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Metallurgical and Chemical Engineering

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Americanism

IF WE do not beat the Germans they will beat us. If the war should end in a draw it is also likely to involve a German victory of the most sinister kind, and for this reason: Unless they become ashamed of themselves in the light of defeat—which seems their only possible source of illumination—Germans who acknowledge the Imperial Government as it is constituted will continue in their abject obedience to any representative of Imperial Authority. They will proceed to lie and practise deceit and offer bribes and foment discord and do any dirty trick they are told to do. Any precious Regierungsassessor or Rat (which is a much-wished-for and instructive title), represents the All-Highest, and it is the interpretation of the wishes of the All-Highest through these media which is the unwritten German law that knows neither ethics nor honor.

Let us hope, however, that in time the German army and navy will be sufficiently shot up to see that it does not pay to rob and steal, and torture prisoners and commit atrocities to show their barbarous prowess, and that finally they may be driven home to worry out their salvation around their own hearthstones. Even then we shall have a stupendous task before us. How long it will be before these acknowledged world-butchers will be allowed to sit at table in conference or stand on the same footing with self-respecting men, whether white or yellow, rests in the hidden lap of the future. To meet them as equals in their present temper, also means defeat. We have gone to war because the Germans were not good enough, and we mean good in the old-fashioned sense of living in sympathy, and taking responsibility for all men of good-will. We have learned already that it will not do to take German ways for our example any more, although we acknowledge the German people to be brave and loyal and competent and efficient. The point is that ethically they have become blind.

Somehow, in the new order of things, we must be strong in many places where we have been weak, if we would avoid the pariah fate of the Germans. New conventions of righteousness must be established. They must become part of the folkways, or attitudes of mind that we expect of everybody. We have dwelt in somewhat of a fool's paradise, leaving admonition to the clergy and rules of conduct to the legislators. But the clergyman has had his own establishment to advance, and his emphasis upon unimportant delinquencies in the interest of his organization has cost him his post of ethical arbiter. The legislator records public opinion in the laws which he helps to enact; he rarely makes public opinion. Moreover, writing ambitions upon the statute books, as we often do, is far from fruitful in good results.

We repeat, there must be new conventions of righteousness established if we are to go forward as a nation on the one hand and avoid the depravity of the Germans on the other. These new conventions will have to do rather with things to be accomplished than with things forbidden. We have seen some very mean and pernicious exploitations of labor in this country and the trouble isn't cured when the evil practices are made illegal. The employment of labor carries with it grave responsibilities; responsibilities that go far beyond the mere purchase of work. And one of the first of these is to see to it that good men and women who do not know the national language and customs shall have a chance to learn them and to become American citizens.

One of the most illuminating men we ever met started in this country as a Neapolitan laborer, in a gang, under a padrone. He could neither read nor write Italian and he knew no other speech. An explosion of dynamite killed a number of his fellows and he was picked up for dead with the upper part of his face, including his eyes, blown clean away. A spark of life was left in him, so he was taken to the hospital where he became interesting for the sole reason that he did not die. When he recovered he was by good fortune sent to that best of the institutions for the blind at Overbrook, Pennsylvania, where he learned first to read and write his own language. Then he mastered English, then French and Spanish and German and then, out of sport and to help him in his work, he took up Russian and a number of other Slavic languages. He now wanders about by himself in New Jersey and Pennsylvania, looking up neglected blind persons and sees to it that they are taught to read Braille, to write on a typewriter, and that they learn trades. Free and with all his faculties, he would have remained a Guinea, worth so much a day and no more, housed in a shack and with no outlook upon life.

Such qualities of exalted citizenship are here and they are available; available, we might almost say, on every hand. If they are turned into destructive channels there is usually a reason why. The incidence of blame is in neglect, and we are learning where to look for it. The time has already arrived when employers must pay something more than wages to their men with hands. The laws generally make it unprofitable to avoid the assurance of physical safety, but that is not all. These men and women must have the chance to become good Americans, they must have decent housing conditions, their children must have good schooling and the opportunity to grow up without corrupting influences.

We know an old gentleman who employs about a thousand men and women. It is surprising to note, in talking with them at hap-hazard, the breadth of mind, the sanity of view and the general indications of culture among them. These qualities seem to increase according to their periods of employment in his establishment. He doesn't preach or lecture or make any fuss over them. He doesn't put on airs or patronize them. But he puts into his daily task the kind of headwork and heart-work that American employers must learn to exercise lest they fail in greater measure than bankruptcy itself; lest they fail in the ideals for which our boys are giving their lives.

The Present Situation in Oil Shale

SOMETHING verging on an old-fashioned "boom" is taking place in oil shales, if the word of the promoter is accepted without discount. Up and down the busiest streets of more than one Western city may be seen show windows containing a mercury retort heated by a plumber's torch, a condenser and one or two Wolff bottles, with which apparatus "liquid gold" or "pure oil" is extracted from a heap of dirt tastefully arranged alongside. Posters remind the observer that three cents invested in Bell Telephone netted three dollars (or thirty dollars—depending upon the fancy of the sign artist) while the furnishing of the office itself consists principally of a desk inhabited by a more oily and efficient gold-extractor in human guise.

The activity of many of these paper companies is no doubt made possible by the lack of "blue-sky" laws, and inspired by the recent report of D. E. Winchester of the U. S. G. S. estimating the amount of material recoverable from the shales in Colorado alone to be of the order of twenty billion barrels of crude oil, two billion barrels of gasoline, and three hundred million tons of ammonium sulphate. Assuming at least an equal amount locked up in the same but less well examined formation in Utah and Wyoming, it appears that here is a reserve of oil products with many times the total holdings of our combined oil fields.

It will probably be found that there will be little profit in mining and distilling shale to sell to outside refining companies. As in other industries, the refinery, the slaughter house, and the smelter will make the sure profit. Again, most of the available analyses show a resulting high-sulphur crude which is already a drug on the market, and would be heavily penalized by existing refineries, if, indeed, it would be accepted. Economically, it seems that good financial results would only follow from operations sufficiently large to provide crude for an individual refinery, which preferably should crack the oil for the maximum yield of light distillate. Such a plant, together with equipment for the recovery of ammonia, will evidently require strong financial backing and excellent technical direction.

Time to Reverse the Old Adage

ON another page we publish a concrete, forward-looking suggestion relating to business and industry in this country after the war. Slow to enter the war, we have also been more deliberate than our European neighbors in anticipating post-war conditions, and preparing as far as possible to meet them.

We believe that no more constructive forces can be thrown into this work than those technical societies representing the industries that have undergone great expansion as a result of the war. The American Electrochemical Society already has decided to devote its next general meeting to a symposium on the future of our electrochemical industries. It seems quite likely that the American Chemical Society, the American Institute of Mining Engineers and the other great national engineering bodies would be of equally great assistance in shedding light on the problems of reconstruction, by scheduling post-war conditions as a subject for consideration at their next general meetings.

A New Turn in Flotation Litigation

THE latest turn of the kaleidoscope of flotation litigation has changed altogether the design and figure to which we had almost become accustomed as one legal decision followed another. With the decision of the Ninth Circuit Court of Appeals, reversing the decision of Judge Bourquin of the District Court in Montana, Minerals Separation is again put sharply on the defensive and the several defendants see the light of possible victory.

Important consequences flow from the latest turn in the litigation, not the least of which is the probability that the United States Supreme Court will again hear the case. But of more immediate satisfaction to the industry must be the clarification of several points that have been as cloudy as some of the scientific theories advanced to explain the process. In the first place, monopoly of the patent in suit is held to be limited to "a (specific) fraction of one per cent" of oil, and that fraction is 0.5 per cent. Second, the allegation that the use of more than one per cent of oil is an evasion of the patent monopoly, is completely upset, and a technicality is wiped out by a saner interpretation of the former testimony. The three judges were in concurrence save on the question of evasion in the use of more than one per cent of oil.

Sacrifices for the Steel Industry

NO PARTICULAR credit accrues to anyone who makes an ordinary sacrifice in these times, for the very fact that it is an ordinary sacrifice deprives it of any distinction. It is with no thought of suggesting that the steel industry deserves particular commendation for what it does that reference is here made to some little sacrifices it finds occasion to make. It is interesting, however, and perhaps stimulating, to mention a few items.

When the steel industry agreed to the "one price for all" dictum of President Wilson it made what was clearly a sacrifice, in the light of existing conditions, because it renounced the opportunity to accept commercial orders that were being offered at much higher prices than those set through the medium of the agreement. The extent of that particular sacrifice in the matter of prices has been gradually reduced until by this time it has really disappeared. It must not be forgotten that the agreement had in it some aspects of a compromise, in that the prices agreed upon, to form the basis of all sales except sales of commercial material for export, were undoubtedly somewhat higher than the Government would have insisted upon to apply in the case of its own purchases. Through the agreement the steel makers have received lower prices on commercial steel, and higher prices on war steel, than would otherwise have been the case. With the diverson of by far the major portion of the output to the filling of war orders the importance of this extra price on war steel is increased.

It is a very important sacrifice that the steel mills make when they ruthlessly cut off deliveries to old and valued customers for the purpose of diverting the maximum possible tonnage to the war work. The great majority of mills have made this diversion very willingly. It would be very unjust to the mills if this diversion were not made universal, for the slackers would thereby be making friends among commercial consumers who might therefore be disposed to patronize them in future, to the disadvantage of the mills which had renounced their trade when called upon to do so for the public good.

Of particular interest is the business sacrifice many steel producers have made in urging their customers to seek substitute materials. The most conspicuous example of this has been the tin-plate trade. The co-operation of that trade with the Government was, moreover, the earliest. Before the country actually declared war the tin-plate makers had pledged themselves to Secretary of Commerce Redfield that they would undertake to divert a maximum quantity of tin-plate to the packing of the perishable food products. That trade is the least stable of the industry's customers, its patronage being seasonal and dependent chiefly upon the magnitude of the crops Nature provides. For years the tin-plate mills have been endeavoring to build up custom by inducing manufacturers to employ tin-plate in place of other materials. As a rule these lines of consumption, which the mills have worked hard to build up, are the very ones that are now ruthlessly denied tin-plate, when the food products call for it, and are asked to find substitutes.

To stimulate the production of steel applicable to the filling of war orders the steel mills are indulging in many divergences from economical practice. They are using as scrap, material that has a high commercial value. For instance: Many mills are using sheet-bar crops as heavy-melting steel, when in the open market they would bring a price far above the heavy-melting steel basis. Shell-discard steel is being used in the same manner, when it could be rolled into finished products such as light rails, concrete reinforcing bars, bedstead angles and the like, at a very good profit. Valuable steel is thus used because the output of steel applicable to the filling of war orders is thereby stimulated. The case is not comparable with conditions in 1916 when with a large production of shell-steel mills were practically forced to melt a large part of their discard material.

Sacrifices of a new order are now being required, the authorities at Washington having begun instructing mills to close certain departments entirely so that supplies of war steel may be augmented. A notable instance of the early operations of this sort was the closing of the rolling departments of a new steel mill in the Cleveland district, the plant being asked to ship its entire ingot output to other plants which could use the crude steel in filling especially important war orders. The plant in question receives merely a price applicable to ingots and is deprived of the profit that would accrue from operating its rolls.

All these things are relative. With the greatest sacrifices that may be made by way of diverging from the most economical practice or the most profitable line of business, the steel mills have much larger earnings, even after the payment of Federal taxes, than have accrued in the best of peace times. That practices which might be denominated expensive are requisite is an argument that care should be exercised to maintain the set prices at such a level as to leave a safe margin. The profits, however, ought not to be permitted to be excessive unless it is intended to tax them still more heavily.

Readers' Views and Comments

The International Technical Affairs Information Service

To the Editor of Metallurgical & Chemical Engineering

SIR:—In spite of the greater efficiency of the individual American, the collective work of the Germans has been far greater in efficiency than the work of the Americans. I repeat, the *collective work was greater.*

The industrialists of this country have come to place more and more dependence upon information in print. To substantiate that statement it is only necessary to count the several hundred libraries operated by our leading industrial houses. The work of these several hundred industrial or technical libraries is extremely valuable, but these libraries, or the majority of these libraries, are working *independently.* The *collective work* of these libraries would aid the industrialist of this country and our allied countries tremendously.

France through the Societe de l'Encouragement pour l'Industrie Nationale, is pushing a national organization for a "technical literary reference bureau to aid the industrialist in the 'economic struggle' after the war." Belgium and Switzerland already have valuable establishments for the collecting and coördinating of scientific literary information.

America has recently formed, under the National Research Council, a Research Information Committee. The platform of this Committee was outlined in the April 1st issue of METALLURGICAL AND CHEMICAL ENGINEERING. In this Committee, so recently formed, there is, or might be, the beginning of a Directional Committee for the coördination of the resources to be found in the libraries of these several hundred industrial or technical libraries about the country, to say nothing of the valuable technical collections in the public, college and society libraries about our country and allied countries.

Believing that some sort of action is needed to follow up the excellent plea made in the editorial to be found in the March 25, 1915 issue of *Engineering News-Record* I have attempted to outline a few steps for the immediate organization of the "association of engineering librarians" called for in this editorial.

First, there should be appointed from the field of industrial libraries, a committee on coördination and coöperation. Second, this committee should earnestly study the most profitable ways of linking together these several hundred technical libraries. Third, the central office of this committee might well be allied with the central office of this newly formed Research Information Committee of the National Research Council, with a branch in all of the principal cities of this country and allied countries. Fourth, this organization should receive government recognition, as perhaps in no other way would certain of our close corporations be willing to open their facilities or unite with other facilities excepting under government orders. Fifth, a certain amount of government aid should be given this organization, as for example franking privileges, in certain operations and free distribution to this International Technical Affairs Information Service of its publications likely to be of value to this Service. Fifth and last, this International Technical Affairs Information Service should function, not only as a directional force in administering the coördinated resources, but it should also act as a large mail-order house of technical information for the industrial house not supporting a technical library.

Technical information is now being made, or put in print by the second. Every day lost in not harnessing this information through this proposed International Technical Affairs Information Service means so much economic loss to the many hundred technical men needing technical information as they never needed it before to say nothing of the excessive demand for technical information after the war. Why not organize this International Technical Affairs Information Service NOW?

K. C. WALKER.

Library, New Jersey Zinc Co.,
55 Wall St., New York City.

Rapid Carbon Determination

To the Editor of Metallurgical & Chemical Engineering

SIR:—The following method for determining the carbon in steel has been used by me with considerable success, in the past few months. Johnson's method is used. The gas is taken from a high-pressure tank through a regular high-pressure reducing combination valve, comprising the diaphragm valve, followed by a needle valve. Both of these valves are kept open during the entire time that the apparatus is in use. The diaphragm valve should be so adjusted that it will admit a maximum of 15 lb. pressure to the train. I believe that the normal setting of these valves is between 15 and 25 lb. Between the valve and the train is a "Y" tube, one branch of which leads to the train, the other to a "U" tube filled with mercury, capable of accommodating at least 20 lb. pressure. This furnishes the "head" for the operation of the train. The gas passes successively through stick caustic, strong caustic potash solution, soda lime and calcium chloride. These reagents are contained in four towers of about 7 in. in height by 1½ in. diameter, with a shoulder at the top, taking a number five, two-holed rubber stopper. The jar containing the caustic potash solution should have about ½ in. of mercury in the bottom to act as a seal in case the rubber tubing between the purifying train and the tank should break. These jars must be of fairly heavy glass with solid bases. They are filled and interconnected so that they occupy a space about 7 in. square. The stoppers are kept tightly in place by setting the apparatus on an 8 in. square board, placing another board of the same size, suitably perforated, on top of the stoppers, and clamping all together with long bolts running from top to bottom. On top of the top board is placed a gas header containing, besides the inlet, three gas valves, preferably those with long handles, as they are easier to manipulate.

The furnace cases are made of 3½ in. seamless steel tubing 1 ft. long. The ends are of asbestos wood.

The combustion tube is of fused silica, and the resistance wire is wound directly thereon for a length of about 9 in. The combustion tube is then placed in the casing and after the leads are secured, quick lime is packed tightly into the case until full. This furnace is very quick to heat, and uses less current, and lasts longer, than when the wire is wound on a protecting tube of alundum or is covered with clay. Moreover, fused silica combustion tubes lose their vitreous character, after some months of continuous use and must be discarded anyway. The furnaces are suspended, side by side, by means of metal straps from two pieces of strap iron, 1 in. by ¼ in., one at either end. These pieces of strap iron are bent in the shape of a square cornered inverted U, and are of such size and height from the table that the openings at the furnaces are a little below the level of the eyes. From the furnaces the gas goes to three sets of zinc-phosphoric anhydride tubes, and from there to the regulation Johnson absorbing bulbs.

The samples are all weighed beforehand into small sheet-metal troughs, closed at one end. These are kept in numbered compartments in a closed box until ready to run. The boats are made of nichrome ribbon. 1 in. by 13 gauge, 3½ in. long. They are simply bent into shape without welding. They are easy to make, last almost indefinitely, and the pigs do not stick to them, unless lead oxide is used. In weighing the absorbing bulbs, weigh them all against a common tare. It is convenient to make all the tubes weigh about the same amount.

Exclusive of the time required to weigh the samples, the writer has repeatedly run ninety carbons in eight hours. Three tubes are used for each furnace; one running, one weighing and one standing. Results on plain carbon steels usually check in the third decimal place. W. L. JACKSON.

E. C. Atkins & Co.,
Indianapolis, Ind.

Special Gold-Recovery Processes Practiced by the Early Portuguese and Spaniards

To the Editor of Metallurgical & Chemical Engineering

SIR:—In an interesting and well-written book, now very rare, entitled "Travels in the Interior of Brazil," particularly in the Gold and Diamond Districts," written by John Mawe, an English scientist and engineer and author of the "Mineralogy of Derbyshire," published in Philadelphia and Boston, in 1816, is a metallurgical reference which may have some import to the intrepid writers who are so readily, but not too lucidly, explaining the theories of flotation. On page 194, Mr. Mawe, in describing the methods practiced in the gold placer districts of Minas Geraes, to recover the gold from the black sands obtained in the major placer operations, says: "Some of the grains of gold were so fine as to float on the surface, and of course, were liable to be washed away in these repeated changes of water; to prevent which the negroes (slaves) bruised a few handfuls of herbs on a stone, mixed the juice in small proportions with the water in their gamellas (pans). Whether this liquid did in reality tend to precipitate the gold, I could not positively ascertain, but the negroes certainly used it with the greatest confidence."

Perhaps some of the flotationists can explain whether this primitive metallurgical application involves any of the present day principles of "surface tension," "ionization," etc., etc., which are invoked in order to justify, after the fact, the marvelous results of flotation as a metallurgical practice. Apparently the early Brazilian process "worked," but I have no information of the continued or wider application of the principle involved. It would be interesting if the delvers in the archives of metallurgy can confirm this observation of Mr. Mawe's.

On the west coast of Mexico, some years ago, I had as my mozo (servant), a very old Mexican miner, who in harmony with his antiquity, still lighted his cigarette with a flint and steel. He told me that in his youth in the mountains of Sinaloa he had been engaged in a gold mining operation in which the gold was refractory and difficult to recover. As an accessory to the metallurgical appliances and processes of that early day, which are more or less well known, it had been found effective in the treatment of this particular ore to crush it in the tahones (Chilean mills) with the leaves of a certain tree, and then to filter the slimes and water from the mill through charcoal, which charcoal was afterwards burned and an appreciable amount of gold recovered thereby. The tree, as it was described, was a species of oak and it was suggested that the leaves might have yielded tannic acid, or some compound related to cyanide. Since the advent into the metallurgical world of flotation, the idea has occurred that possibly this metallurgical practice of the early Mexicans was a crude precursor of flotation.

Is it not possible that these two instances of primitive metallurgy represent the early application of differential and selective adhesion of special solutions somewhat similarly as in the modern flotation processes and their modifications? KIRBY THOMAS.

New York, N. Y.

Influence of Temperature of Measurement on the Electrical Restivity and Thermo-Electromotive Potential of Solutes in Steels

To the Editor of Metallurgical & Chemical Engineering

SIR:—In your issue for November 15, last, you republished from a preprint of the American Electro-Chemical Society an article which I presented to that Society at its meeting in October. Your journal naturally reprinted it exactly as it appeared in the preprint, but proof of this article was never sent me before it appeared in the preprint. There were one or two minor mistakes in the title of the article, but these were not at all serious. There was, however, one serious mistake which arose from the fact that the printer in setting up the article omitted an entire line so that the meaning of the sentence was naturally lost. This sentence occurs near the top of the second column on page 592 of your journal. This sentence should read "would transform a maximum amount of electrical energy into heat, thus causing a maximum electrical resistivity."

E. D. CAMPBELL.

University of Michigan, Ann Arbor, Mich.

Western Metallurgical and Chemical Field

Conditions in Joplin-Picher Region

THE Joplin *News Herald* recently published interesting tables showing the production of blende, calamine and lead from the various camps in that region for the years 1916 and 1917. These tables furnish the basis of the following figures:

	Approximate Average Weekly Production of Blende for		Production for Week of	
	1916	1917	Oct. 20, '17	Apr. 14, '18
Highest grade blende (basis 60% Zn)	....	....	$75 per ton	$55 per ton
Price of zinc	....	....	7.9c.	7.0c.
Production:				
Oklahoma camps	2,080,000	5,920,000	8,463,000	7,323,890
Joplin	2,180,000	1,820,000	1,747,860	817,750
Webb City-Carterville	4,540,000	3,340,000	2,087,020	957,750
Duenweg	1,330,000	1,080,000	1,620,680	....
Total, including miscellaneous camps and calamine	14,150,000	15,700,000	18,205,210	12,701,760

The yearly figures show very plainly the rapid growth of the Oklahoma camps at the expense of the older fields; the Webb City—Carterville "sheet ground" district suffering the most. Many mills have been moved from the regions nearer Joplin to the richer Oklahoma camps, which have been able to continue much more nearly at its high rate, despite the low price of ore. The sheet ground mines are almost all down. From Duenweg to Oronogo there are only about a dozen mines and mills in operation where there were eighty a year ago.

Such conditions has provoked much discussion among the operators in the Tri-State field, resulting in resolutions calling for a tariff on imports of zinc ore amounting to two cents a pound. Their association has also appointed a committee to go to Washington in an attempt to interest the President directly in measures for their amelioration.

In the face of the rapid decline in the price of spelter occurring since the summer of 1917, the agreement between producers and the War Industries Board on a price for Grade A zinc brought a gleam of hope. This agreement was made in February under the usual stipulations as to uniform price, wages, production and speculation, and fixed 12 cents a pound for Grade A zinc, 14 cents a pound for plate zinc, and 15 cents a pound for sheet zinc thinner than ½ inch. While the Joplin district produces but little of this material, still if the usual pre-war differential between sheet-zinc and prime western continued to exist, it would automatically place some sort of regulation on their product. Unfortunately this spread, which was 2.15 cents in August, 1914, has continued to widen, and the general zinc market has continued to slump.

The prospect of the government finding a larger use for that spelter which has hitherto been barred from Grade A owing to the presence of a little more cadmium than is permitted by the standard specifications has been carefully considered. It is not supposed that the specifications on Grade A will be lowered, but a higher cadmium zinc may be accepted on certain government work at a small discount from the Grade A price. If the smelters, on the other hand, could be induced to abandon the time-honored schedules, and pay an extra figure for cadmium-free ores, it is thought certain that considerable concentrates very low in lead, iron and cadmium could be selected and marketed for the production of Grade A. Meantime, with the increasing spread between prime western and higher grades, the margin available to cover redistillation costs becomes wider, but the resulting production of Grade A spelter affects the prosperity of the miner and millman but slightly.

The Pacific Kelp-Potash Industry

Several concerns are now engaged in the manufacture of potash from kelp on the southern Pacific coast, notably the Pacific Products Company, the Sea Products Company, and the Oceanic Engineering Corporation at Long Beach, the Lorned Manufacturing Company at Summerland, the Hercules Powder Company and the Swift Fertilizer Company at San Diego, California. The Bureau of Soils of the United States Department of Agriculture began the construction of an experimental plant for the extraction of potash from kelp last April at Summerland, California, and has operated since the latter part of August, under the direction of J. W. Turrentine.

The purpose of this plant is two-fold: To determine the cost of producing potash from kelp, but more especially to determine what byproducts can be simultaneously produced commercially. The product to date has been principally kelp char containing about 30 per cent K_2O, which has been produced incidentally in experimenting in methods for drying and distilling. This has found a ready sale at a very good price—practically paying the operating costs of the plant. There is of course a great demand for potash in the fertilizer and other industries, and for the iodine and other chemicals recovered as a by-product.

The plant has a capacity of about 150 tons per day, which can probably be increased to 200 tons after certain refinements in operation have been introduced. Apparatus is now being installed which will make possible the production of high-grade muriate and numerous byproducts. The present installation has cost approximately $100,000 and consists essentially of a self-propelled kelp harvester of a harvesting capacity of about 25 tons per hour, and a carrying capacity of 100 tons. The shore plant contains unloading devices and conveyors for delivering the kelp to storage bins, the latter of a capacity of about 300 tons; a drier house containing three direct-heat counter-current rotary kilns, 50 feet long by 5.5 feet in diameter, with furnaces; and the necessary vacuum evaporator, crystallizer and lixiviating apparatus.

Arizona Copper Company Increases Mill Capacity

During recent months, Mr. Arthur Crowfoot, mill superintendent for the Arizona Copper Company, has been able to increase the daily capacity of their mill at Morenci from 2800 to 4000 tons with virtually no important additions to the area of the plant. The increase has been effected by a revision of the flow sheet, necessitating the installation of two Symons disc crushers in the crushing division, the elimination of jigs, the installation of a new floor of tables, and the construction of additional large settling tanks. The last item of construction has just been completed, and includes very large Dorr thickeners for dewatering the tailings as well as the concentrates. This practice is necessary in order to conserve as much water as possible—fresh water is

pumped a distance of about six miles against a considerable head. Since it requires approximately 450 gallons of fresh water per ton of ore concentrated in order to sluice the tailings down the canon to their disposal, at least that amount of water must be added to the mill heads. A very interesting design of water meter after the order of the tilting tank washer has been installed in the concrete reservoir acting as a supply tank for the operations of the concentrator.

A particularly noteworthy feature of the concentrator is the installation of a dust-catching system in the crusher division. Gyratory, disc crushers and rolls for reducing 4000 tons of mine run to $\frac{3}{4}$-inch size are housed in and connected to an exhaust fan, which delivers the dusty air to a centrifugal dust catcher. The solids are sprayed with water while circulating through the catcher, and the separation is so nearly complete that little dust can be observed in the exhaust. The atmosphere in the crushing division itself is very clear, and the installation may be said to have solved the dust problem in the dry-crushing plant.

A 100-ton experimental mill is being installed in a building formerly used as a crushing plant before the new main hoisting shaft was sunk. In this plant methods will be studied of concentrating low-grade sulphides containing in the neighborhood of one per cent copper, which the company possesses in very large quantity. The first trials will be on floating the finely-ground eject from a Marcy mill, with table cleaning of the flotation tailing.

Portland Company Closes Colorado Springs Plant

The exhaustion of bonanza mines is often referred to as the reason why a large expansion in metallic production does not follow war prices. Unfortunately gold production is hindered rather than helped by high prices, but the continuing exhaustion of known deposits is as patent as those of other metals. Witness the closing of the Colorado Springs plant of the Portland Gold Mining Company, of which a final clean-up was made in April. This mill was built to treat high-grade ores only, and is useless now that the high-grade ores of the Cripple Creek District are being exhausted. In its sixteen years of life it has extracted gold at an average rate of over two million dollars per year, but during the past years there has been a constant decrease in the tonnage of high-grade ore shipped, owing to a lessened production of the district, this doubtless accentuated by the shortage of efficient labor and the high cost of fuel, powder, timber, and other necessary supplies.

The Portland Company foresaw the probable shutdown of the Colorado Springs plant and provided room for the treatment of their own and custom high-grade ore when constructing their new Independence Mill, expecting to transfer the necessary machinery and workmen from the older plant. The Independence Mill, by the way, was primarily designed to treat monthly about 42,000 tons of low-grade ore from dumps and old workings, the latter estimated to amount to about three million tons. Eventually all milling operations of the Portland Company will doubtless be done at this new mill, which is modern in every respect, since the Victor Mill, built eight years ago as an experimental plant to handle ores too low in grade to bear shipment, was constructed at the mine on an unfavorable location. It has earned net profits more than double its original cost, however, while the net earnings of the Colorado Springs plant amount to several times the original cost of that plant.

By-Product Coke Plant at Pueblo

Two batteries, each of 60 Koppers ovens, are nearly completed at the Minnequa plant of the Colorado Fuel and Iron Company at Pueblo, Colo., and have the distinction of being the first of their kind west of St. Louis. The operations of the by-product coke department will be in charge of H. B. Carpenter as superintendent. The ovens are of the regenerative type, with vertical flues, and are 40 feet long, 10 feet high, and 19 inches wide, with a capacity of 12½ tons of coal, which charge produces 8½ tons of 16-hour coke. This installation can therefore carbonize 70,000 tons of washed Trinidad coal per month, making 46,000 tons of coke and distributing daily 600,000 cubic feet of by-product gas at a pressure of five pounds per square inch to the open-hearth department, heating furnaces and soaking pits.

The hot coke will be pushed into a transfer car, taken to a brick quenching station and drenched by a large spray of water, and thence to a coke wharf, down which it slides. A rotary feeder then delivers it to a 42-inch conveyor leading to a screening station; the large coke goes to the blast furnaces, and the breeze and dust are burned in Cox stokers under steam boilers.

Tar from the primary coolers, gas mains and tar extractors is separated from ammonia liquor in a tank by specific gravity, and loaded into tank cars for shipment. A complete plant for the recovery of by-products from the oven gas has been installed. Ammonium sulphate, benzol, toluol, xylol, solvent naphtha and naphthalene will thus be separated and purified for the market.

New Picric Acid Plants

Contracts have just been completed by the Ordnance Department for the establishment of two large picric acid plants. Sites have been selected at Little Rock, Arkansas, and Brunswick, Georgia, and the construction work will be rushed at once by the contractors. Men and material for the buildings are all ready on the ground at Little Rock, and it is expected that the plant will be in operation by September.

The Everly M. Davis Chemical Corporation has been awarded the contract for the Little Rock plant, the construction of which will cost approximately $4,000,000.00.

A larger plant is to be constructed by the Butterworth-Judson Co., of New York City, at Brunswick at a cost of nearly $7,000,000.

These are the first government-controlled picric acid plants to be established in this country. The sites were chosen in the South after a most careful investigation of housing, labor, transportation facilities, and strategical conditions. In choosing the Little Rock location, the Ordnance Bureau was able to take over a number of buildings which will be used as part of the plant.

The location of these plants in the South, in addition to the two nitrate plants now located at Sheffield, Alabama, makes that section of our country preëminent in the manufacture of chemicals by the Government for production of explosives.

Water Power Hearings Closed

Joint Water Power Committee of Congress Begins to Draft Bill

THE record of the special hearings held on waterpower development was closed May 18 after listening to the news of Secretaries Baker and Houston, who, with Secretary Lane, comprise the commission proposed in the Administration bill. A formal statement by William H. Onken, Jr., editor of *Electrical World* was submitted and added to the record.

Statement of Secretary of War Baker

Secretary Baker commented on the bill as originally submitted by the three secretaries and also on the effect of the proposed amendments subsequently offered. The latter he said were introduced for the purpose of clarity. His own view is that the terms of the franchises provided for in the "administration" waterpower bill shall be definitely limited to fifty years. On this point his testimony was as follows:

"We have to decide at the outset whether a fixed term is to be used, at the end of which there is an end of the rights of the licensee, or whether we are going to spread the investment of any licensee over an indefinitely prolonged period under proper safeguards. If it be determined that a single term of fifty years is to be the principle of the bill, then any investor must, whether you provide it in the bill or not, amortize the investment in fifty years. That means that the consumers during the fifty years will have to pay by that much a higher rate than they would have to pay if they covered in their rates merely obsolescence and replacements and did not sink the entire original cost during the period of the grant. If the primary object is to secure a minimum rate to the consumer, the course of having consecutive terms would be the proper course.

"The purpose of this bill was to have a fifty-year term, and at the end of the fifty-year term the government was to have the three options of either taking over the property, granting it to a new licensee or regranting it to the original licensee or his successors in interest. The intention of the bill was to make those three options identical, so far as the financial obligation was concerned. If the government took it over, it would pay X dollars; if it granted it to a new licensee, the new licensee would pay X dollars; if it regranted it to the original licensee, it would ascertain and fix, as a new starting point for his net investment, X dollars, the same number of dollars in each instance. The purpose of the bill, as originally drawn, I think—and certainly as clearly shown by the amendment—was not to sink and amortize the original cost during the first term, but to carry that investment—depreciate it so that at any particular period of renewal it represented the actual value—to carry that forward as a continuing asset in the licensee, either to be repaid to him by any other licensee or by the government or to be regarded as his investment at the beginning of the new license period.

Secretary Baker Favors Fifty-Year Term Without Privilege of Renewal

"Now, my own judgment, my very strong preference, is for the first of those courses, to fix an absolute term and to allow the government not to have a system of equities built up against it at the end of that term. If that were done, it would cost more to the consumer clearly, but if it is intended to do that, it ought to be so clearly done that when the first term or first license does expire, there will not be any doubt that the government has a right to expect the licensee to have protected himself by amortization during the period.

What Constitutes Fair Value

Secretary of Agriculture Houston, in discussing net investment as defined in the amended measure, said that the original draft of the bill provided for recapture of the water power development at fair value. In suggesting the term "net investment" as the basis for payment it was thought it would not be susceptible to any misunderstanding or misinterpretation inasmuch as the term was specifically defined. However, it is inconceivable that there should be any unappropriated surplus to deduct from the original cost as required in the measure (see *Electrical World*, March 16, page 581), and for that reason he suggested the following amendment to the clause on "net investment" as defined in the amended measure or to "fair value" as understood in the original draft:

"That out of surplus earnings, if any, accumulated in excess of a specified rate of return upon the net investment of the licensee in any project or projects under license the licensee shall establish and maintain amortization reserves, which reserves shall, in the discretion of the commission, be held until the termination of the license or be applied from time to time in reduction of the net investment. Such specified rate of return and the proportion of such surplus earnings to be paid into and held in such reserves shall be set forth in the license."

Should the government at the end of the fifty-year period take over the project that sum would be deducted from the original cost. Whether or not to make amortization within the fifty-year period compulsory was a question of policy for the committee to decide. To do so would mean higher rates for the electric service during the life of the franchise, which the utility has a perfect right to exact.

Statement of William H. Onken, Jr.

The question of waterpower development has been so fully discussed before various congressional committees during the past six years that it is difficult to contribute anything new to the voluminous testimony already forming part of the record. However, it may be pertinent to observe that notwithstanding all the light that Congress has received on the subject, we still lack legislation due to the failure of legislators themselves to agree.

In view of the fact that electricity is now more and more a necessary part of our social and industrial life, and that its uses for purposes of irrigation and for the manufacture of nitrogen for explosives has become a matter of trmendous import in our national defense, might it not be well to abandon all theories of ideal legislation and adopt some practical measure as speedily as possible?

THE VALUE OF CHEAP ELECTRICITY TO INDUSTRY

As typifying what hydroelectric development means to a community and at the same time showing the enormous waste caused by non-development, the case of Niagara Falls is unique. The mighty cataract alone, not including the rapids is capable of developing five million horsepower. This, if sold at the modest rate of twenty dollars a horsepower, or what is equivalent to 3 mills per kilowatt-hour would yield a revenue of one hundred million dollars per annum. This amount of money is qual to a 5 per cent return on an investment of two billion dollars, and yet what government would spend that stupendous amount of money to reproduce the spectacle? It is true, we have power companies which develop a fraction of the power available, but the roar of Niagara is as nothing compared to the din of the industries set in motion by the electricity generated from a fraction of the water in the falls.

At Niagara Falls are located the greatest electrochemical industries of the world. More would be located there if more power were available but because of the shortage of power many have been forced over into Canada, and still others have gone abroad. These electrochemical industries are of vast importance to this nation. They started at Niagara Falls and for the greater part they still remain, handicapped as they are for want of electricity. On these electrochemical industries depend numerous other industrial establishments throughout the country, valuable in time of peace, but infinitely more valuable in times of war.

First of the electrochemical enterprises in point of electric power requirements is the aluminium industry. Next in line come the ferroalloy compounds including ferrosilicon, ferrochromium, ferromolybdenum and so on. The next electrochemical industry in point of size is devoted to the manufacture of calcium carbide used chiefly in the production of acetylene. Artificial abrasives which constitute the basis of all modern grinder work are also manufactured at Niagara Falls, as well as caustic soda, chlorine in the form of bleaching powder and other chlorine products; chlorates which are used in the match industry, in the textiles, for the manufacture of oxygen and in other chemical operations; sodium used in the textile industries as a bleaching agent, and which is still more important in the manufacture of sodium cyanide; phosphorus, carbon disulphide and numerous other products absolutely indispensable to industry today.

MORE VALUE IN INDUSTRIES CREATED THAN IN WATER POWER

It is needless for me to continue further along this line to impress you with the vast importance of electrochemical products to other industries, ignoring entirely the fixation of atmospheric nitrogen for fertilizer and for munition work. I merely cite the case to show how infinitely more important are the industries depending upon electricity than the electric generating system itself. It is of interest to note in this connection that the combined income from the sale of electrical energy of the Niagara Falls Power Company and the Canadian Niagara Power Company for 1917 was a trifle over $3,000,000. I have no statistics showing the output of electrochemical products manufactured from the electricity sold for that purpose nor the cost of the numerous other products which in their fabrication involve electrochemical products. However, the citations given indicate the stupendous value of these products as compared with the cost of the electricity used.

Annual Meeting of the American Society For Testing Materials

The twenty-first annual meeting of the American Society for Testing Materials will be held at Atlantic City June 25 to 28, 1918, with headquarters at the Hotel Traymore.

A provisional program has been announced as follows:

Tuesday morning, June 25.
- Minutes of the 20th annual meeting.
- Annual report of the Executive Committee.
- Reports of technical committees.
- Announcement of election of officers.
- Miscellaneous business.

Tuesday afternoon, June 25.
- Reports of committees on wrought iron, cast iron, and testing.
- A Simple Type of Brinell Testing Machine for 500 kg. Load. A. V. de Forest.
- A New Type of Brinell Machine. J. G. Ayers, Jr.
- Effect of Moisture on the Strength of Aircraft Fabrics. G. B. Havens.
- Transverse Testing under Non-Uniformly Distributed Load as Applied to Airplane Wing Ribs. I. H. Cowdrey.
- Sumner Elastic-Limit Recorder. J. L. Jones and C. H. Marshall.

Tuesday evening, June 25.
- Annual address by the President, followed by a reception.

Wednesday morning, June 26.
- Reports of committees on steel.
- Cast Steel Anchor Chain. James French.
- Grain Growth of Cold Wrought Metals. D. J. McAdam, Jr.
- Changes within the Critical Range of a Given Steel: From Ac_1 to Ac_{2-3}. J. G. Ayers, Jr.

Wednesday evening, June 26.
- Topical discussion on coöperation in industrial research, by Dr. Henry M. Howe, Dr. John Johnston, Dr. A. D. Little, Dr. Charles L. Reese and Mr. Frank E. Gorrell.

Thursday morning, June 27.
- Reports of committees on preservative coastings and non-ferrous metals.
- The Valuation of Zinc Dust and a Proposed Method of Analysis. L. A. Wilson.
- Topical Discussion on "Season and Corrosion Cracking of Brass: Its Prevention and Means for Testing the Tendency Thereto."

Thursday evening, June 27.
- Joint session with the American Concrete Institute on cement and concrete.
- Reports of committees and papers on cement and concrete.

Friday morning, June 28.
- Reports of committees on lubricants and lime.
- The Standard Saybolt Universal Viscosimeter. W. H. Herschel.
- Internal-Combustion Engine: Lubrication and Lubricants. P. H. Conradson.
- The Variable-Pressure Method of Determining the Viscosity of Oils. E. C. Bingham.
- Mechanical Sifting of Cement. D. A. Abrams.
- Effects of Grading of Sands and Consistency of Mix upon the Strength of Plain and Reinforced Concrete. L. N. Edwards.

Friday afternoon, June 28.
- Reports of committees on ceramics and refractories.
- The Necessity for Inspection and Testing of Refractory Brick. C. E. Nesbitt and M. L. Bell.
- Silica Cement. R. J. Montgomery.
- An Abrasion Test for Gravel and Stone for Road Purposes. H. H. Scofield.
- Sampling of Deposits of Road Stone and Gravel. L. Reinecke.

Friday evening, June 28.
- Reports of committees on fireproofing, coke, waterproofing, electrical insulating materials, shipping containers, and rubber products.

Minerals Separation vs. Butte & Superior

Opinion of District Court in Favor of Plaintiff Reversed by Court of Appeals—Contentions Repudiated Regarding Non-Effective Oils—Minerals Separation Process Not Infringed by Use of More Than One Per Cent Oil

On May 13, 1918, the United States Court of Appeals for the Ninth Circuit, at San Francisco, filed its opinion in the Minerls Separation-Butte and Superior Case.

Each of the judges wrote an opinion, Judge Ross and Judge Hunt, in concurrence, giving the majority opinion, while Judge Morrow wrote an opinion concurring in part and dissenting in part.

The opinions were rendered in a review of the decision of Judge Bourquin, of the District Court of Montana, which was given Aug. 25, 1917, and from which the defendant, the Butte and Superior, appealed.

Judge Bourquin's opinion, it will be recalled[1], was very strongly in favor of the contentions of Minerals Separation, and as Mr. Canby pointed out in his comprehensive review of the American litigation up to that time[2], Judge Bourquin's opinion practically reëstablished the original claim 12, so wide a scope did he allow Patent 835,120. He found that the defendant, in increasing its use of "oil" to an excess of one per cent, had done so by the use of certain oils which Judge Bourquin said were inert and useless, or even harmful, "having no more effect than so much milk or other useless substance," while maintaining the pine oil at about the same quantity which they had been using prior to Jan. 7, 1917, the date of the U. S. Supreme Court decision. Judge Bourquin thus discriminated between what he considered effective and non-effective oils, and decided that the defendant could not escape infringement by the addition of the latter.

In the presentation before the San Francisco Court the experts for Minerals Separation, among others, performed an experiment by way of demonstration to show that these petroleum oils which defendant was using were not frothing oil and would not produce a "froth." But unfortunately for their contention, and in absolute contradiction to the statements being coincidentally read from record by plaintiff's counsel, a really excellent froth was produced, so that the judges must have been more impressed by what they saw than by what they heard, since all three of the judges repudiated this distinction as to effective and non-effective oils.

Using More Than Fraction of One Per Cent of Oil Is Not Infringement

Even Judge Morrow, whose opinion is the dissenting opinion of the Court, says—"I am of opinion that the use of an oil or oily liquid in defendant's separation process in a quantity *not* 'amounting to more than a fraction of one per cent on the ore' is within the express terms of Claims 1, 2, 3, and 12 of plaintiff's patent, and is an infringement of such patent. But I am of the opinion that the use of an oil or oily liquid amounting to more than a fraction of one per cent on the ore is not within the terms of Claims 1, 2, 3, and 12 and is therefore not an infringement upon plaintiff's process . . . ."

We have been so long accustomed to think of the Minerals Separation patent (835,120) as being the use of one per cent of oil, that possibly few of us realize just what the patent really does mean, as decided by the U. S. Supreme Court and now interpreted by the Court of Appeals in San Francisco as its meaning, and that is that "a fraction of one per cent" does not mean every fraction of one per cent, but only that fraction of one per cent constituting "critical proportions."

Since the claims of a patent can not be broader than the discovery or invention it would seem clear that the claims of this patent, 835,120, referring to "a fraction of one per cent" should not be so broadened as to include a greater percentage than that embraced in this discovery. If this is so, Minerals Separation's exhibit of Higgins' report of the experiments as to the effect of reducing "oil" in the Cattermole process, clearly shows that it was at about half of one per cent that the effect constituting the discovery, was first apparent.

What Constituted Invention in M. S. Process?

In the argument before the U. S. Supreme Court there took place a colloquy between Justices McReynolds and Pitney, and counsel for Minerals Separation, which Judge Ross quotes in full, and to which Judge Hunt refers in these words:

> Again, when counsel had a colloquy (quoted in the opinion of Judge Ross) with the Supreme Court, the guiding thought evident in the mind of the inquiring Justices was to stamp precision upon the point when *invention in the process* began to appear. With apparent definite purpose of meeting the interrogatories plaintiff told the court that "invention" began to come when in the descending uses of percentages of oil as small quantity as five-tenths of one per cent was used, and was first present when three-tenths and two-tenths of one per cent was used. Of course a court should cautiously consider a response often quickly made by counsel in answer to questions put from the bench lest an injustice may follow by attaching undue weight to an isolated argumentative answer, but in this matter we are earnestly trying to gather the scope and accurate meaning of the expressed thought of the court. We may therefore refer to the fact that the exact position of the plaintiff as to the invention was called for not once but twice, not generally nor indirectly, but positively, simply and unequivocally.

The colloquy above referred to has appeared in journals reporting the proceedings before the Court, so that we need not quote it again from Judge Ross's opinion, of which it forms an important part. and although one can well imagine the chagrin of counsel in having such a colloquy forming so large a part of the Court's opinion, that is as to space occupied, and as shown in the above quotation from Judge Hunt's opinion, as to its determining force in interpreting the opinion which the U. S. Supreme Court intended to express, and, also, undoubtedly in determining the opinion of the U. S. Supreme Court itself, through the information which the colloquy gave to them, the actual fact as to the scope which the claims to Patent 835,120 would be entitled is in reality determined by the plaintiff's statement of the discovery as set forth in the Higgins' report, above referred to. One can not but assume that the U. S. Supreme Court, even without such a colloquy, would have decided as it has done, and that it was indeed such an appreciation of the scope of the discovery which led the Justices to make the inquiries.

[1]Met. & Chem. Eng., Sept. 15, 1917.
[2]Eng. & Min. Jnl., Dec. 1, 1917.

Three Points at Issue

Notwithstanding the very voluminous record in the case, and the many angles presented through the several hearings in the various cases up to this hearing, there was presented to the court in San Francisco practically only three points for decision. These were as follows:

First. What had the Supreme Court decided as to the bounds of the invention, and does the use of oil in proportions greater than the so-called "critical proportions" violate any rights of the patentee?

Second. Does the evidence in the Butte and Superior case contain anything which was not before the Supreme Court, of such a nature that that Court would have been led to a different conclusion if it had been presented in the Hyde case?

Third. What is the purpose and effect of the so-called "disclaimer" filed by the plaintiffs after the opinion of the Supreme Court in the Hyde case was handed down?

As to the first of these, Judges Ross and Hunt are of the opinion that the Supreme Court meant what they said as to "critical proportions" and that they did not mean that Claims 1, 2, 3, and 12 included all percentages of "oil'" up to one per cent. "A fraction is one thing, every fraction is a different thing," says Judge Ross, and continuing, adds: "It is obvious, we think, that if the Supreme Court had meant to extend the scope of claims * * * of the patent to one per cent of oil on the ore as is here contended it would not have said anything about any fraction of one per cent. Certainly there would have been no necessity for doing so and certainly the use of such specific language as it employed without a purpose cannot be justly imputed to that great tribunal." Then after copious quotations from the decision of the Supreme Court, in the Hyde case, Judge Ross continues: "Nothing, it seem to us, can be clearer from the foregoing quotations from the opinion of the Supreme Court, than that it did not intend to extend the monopoly of the patent in suit to the use of one per cent of oil on the ore; for it, in effect, thereby distinctly declares and adjudges that the discovery of appellee "experimenters" only rose to the dignity of *invention* when they ascertained that the desired results could be and were obtained by the use of five-tenths ($\frac{1}{2}$) of one per cent of oil on the ore."

As to the second of the three points, above referred to, had they found sufficient new evidence to warrant them in so doing, they might have gone outside of the Supreme Court decision, even to the extent of finding the process of the patent anticipated, but this they did not do.

As to the third point, that is purely a legal technicality as to certain alleged undue delays in entering disclaimers as to the claims which were declared to be invalid by the Supreme Court, in the Hyde case, those claims in the patent calling for simply "a small quantity" of oil. The Court of Appeals found that there had been no illegal delay.

"The decree appealed from (in the District Court) must be and is reversed and the case remanded with directions to the Court below to so modify its decree as to accord with the opinions of the majority of this Court, the appellant to recover its costs on this appeal."

Annual Meeting of the New York Section American Institute of Mining Engineers

Symposium on the World's Iron Ore Resources—Election of Officers

THE annual meeting of the New York section of the A.I.M.E. was held in New York, May 28, 1918. Minor changes were made in the by-laws and the following officers were elected for 1918: Chairman, A. H. Rogers; vice-chairmen, Forest Rutherford, H. C. Parmelee; treasurer, Frederick T. Rubidge; members of executive committee, J. E. Johnson, Jr., and P. G. Spilsbury.

The meeting was a symposium on the iron ore resources of the world in relation to national economic conditions after the war. E. C. Harder, Waldemar Lindgren, C. M. Weld, A. C. Spencer, H. Foster-Bain and Sidney Paige each addressed the members present on different phases of the subject.

The Brazilian Iron Situation

E. C. Harder of the University of Minnesota presented a paper on the Brazilian iron situation.

He stated that Brazilian iron ores would now be offered in European and American markets had not the necessary capital been diverted for war purposes. It is considered equally certain that they will be a prominent factor in the reconstruction of Europe. The Brazilian iron-ore field takes rank among the five great iron-ore districts of the world, the others being (1) the Lake Superior district of the United States, (2) the Lorraine ore field of northern France and Southern Germany, (3) the northern Sweden deposits and (4) the ore fields of Oriente, Cuba. The Brazilian field is the greatest known undeveloped iron-ore district in the world, and its aggregate tonnage is variously estimated up to three billion and a half. The largest deposit contains at least five hundred million tons, and deposits containing from ten to fifty million tons are numerous.

The iron-ore district is about 100 miles square and is in the State of Minas Geraes, its center being about 250 miles north of Rio de Janeiro, with which city it is connected by the Central of Brazil Ry. A new railroad, the Victoria a' Minas, designed for ore transportation, is now under construction from Victoria.

Two types of ore occur. The more important interbedded variety gives a high-grade hard ore averaging 69 per cent iron, low silica, and less than 0.02 per cent phosphorus, and a low-grade soft ore averaging 60 to 68 per cent iron, depending upon the amount of silica, and from 0.01 to 0.07 per cent phosphorus. The other type is a product of weathering and is of lower grade but ranges up to 65 per cent iron and a phosphorus content of from 0.1 to 0.3 per cent.

Previous to 1910 practically all these deposits had been owned by Brazilians, but soon after that they gained publicity and were rapidly acquired by English, American, French and German interests. The English and American holdings are more important and include practically all of the deposits which will derive benefit from the new railroad. The German and French interests are tributary to the old railroad, which is scarcely able to handle its present manganese business.

It is still questionable as to just what use these ores will be put. Brazil itself does not at present offer a market and possesses no coal deposits suitable for iron manufacture. This lack of coal has been the great factor in retarding the development of the iron deposits; it necessitates exporting this great national resource of Brazil, which fact has caused the Brazilian government much concern but is now accepted as inevitable.

England has imported annually during the last few years about 4,500,000 tons of iron ore from Spain, about 1,000,000 tons from northern Africa and about 800,000 tons from Scandinavia. It is hoped that the Brazilian output may eventually reach 10,000,000 tons annually which will be sufficient to supply England's demands for foreign ores and leave a surplus for the United States and for other countries.

In the United States the Brazilian ores will probably be found to be a very desirable furnace mixture for low-grade ores and for more refractory ores. They will doubtless also be used in the Bessemer furnaces to replace the gradually decreasing supply of domestic Bessemer ores.

The great fleet that will be necessary to carry the iron ore to the United States and Europe will be used to carry return cargoes to Brazil. This will offer cheap transportation for such products as coal, iron and steel manufactured articles and cement. It will aid greatly in the industrial development of the country and perhaps eventually it may be possible to operate small iron and steel plants in Brazil at a profit to supply the domestic needs of iron and steel products.

Swedish Iron Ore Reserves

Dr. Lindgren discussed the Swedish and Norwegian iron-ore deposits. He stated that the deposits in the central part of Sweden were divided into three groups. The first group consisted of high-grade magnetites imbedded as lenses in limestones and dolomites. There are small quantities of these ores and they are of no importance for export. They are used in Sweden in the production of high-grade iron. Associated with the magnetites are banded hematites which are also of only local interest. The apatite iron ores of central Sweden are of importance as the reserves amount to 100,000,000 tons and a considerable exportation of them is carried on. The total reserves of central Sweden amount to 122,000,000 metric tons. These deposits are of minor importance to the world as a whole.

The Lapland deposits in northern Sweden at Gellivara and vicinity were stated to be of the greatest importance as the ore reserves totalled 1,150,000,000 metric tons and are concentrated in a comparatively few large deposits. The iron ores are rich in phosphorus, only a small proportion being as low as 0.05 per cent phosphorus. The bulk of the ores average 58 per cent iron and from 1.5 to 3 per cent phosphorus. The deposits are opened by a railroad which extends from the Baltic to the Arctic ocean, and, while the severe climatic conditions interfere with operations, a production of 7,000,000 tons per annum was made according to the last reports. Under pre-war conditions one-third of this ore was shipped to England and two-thirds to Germany. The iron ores of Norway are of less importance and total 280,000,000 metric tons. As much of this ore is low grade its exploitation is dependent upon the success of concentration methods.

Importance of Cuban Iron Ore

A description of the Cuban iron ore deposits was given by C. M. Weld. He estimated the total tonnage at 3,000,000 tons. They form surface blankets of great extent, averaging from 15 to 25 ft. thick and ranging from 1 to 70 ft. in thickness. There is no overburden. The ore is high in hygroscopic and combined water, the total of water reaching 35 per cent. The phosphorus content is below 0.02 per cent and the ores contain 0.5 to 1 per cent nickel and 1.5 per cent chromium. The steel made from the ore has valuable properties. The deposits are of first importance.

The Iron Ores of China

The iron ore deposits of China were briefly reviewed by H. Foster Bain, of the U. S. Bureau of Mines. Mr. Bain said that while it is still too early to make complete estimates of China's resources enough is known to warrant approximate figures. Stated in the briefest terms the approximate probable tonnage of the known deposits suitable for modern uses is 402,000,000. Of this the Chinese government retains title to about one-third, Chinese companies claim somewhat less than one-third, and Japanese or Sino-Japanese companies have over one-third. These estimates do not include all of the iron ore as doubtless there are deposits still to be discovered and in the smaller bodies suitable only for native furnaces or far in the interiors there is not improbably 300,000,-tons additional.

Mr. Spencer gave the following figures for the reserves of Europe and Africa in metric tons:

Continental France, not including Alsace-Lorraine, 2,000,000,000; Spain and Portugal, 730,000,000; Austro-Hungary, 200,000,000 to 300,000,000; Greece, 100,000,000, Algeria, 150,000,000.

Fixed Price for Toluol

The War Industries Board has had its attention called to the fact that in some instances excessive prices are now being demanded for toluol when sold under release for other than military purposes.

When Government action or demands in any branch of trade results in material increase in price, it is incumbent upon the Government to protect other users of the commodity by seeing that the price to the trade does not advance to a point in excess of the price paid by the Government.

In accordance with this the War Industries Board has extended the Government price to cover all toluol which will be released for non-military purposes.

The Government price is:

Carload lots in tank cars............$1.50 per gallon
Any quantity in drums..............$1.55 per gallon

No release will be granted for shipment of toluol where a price in excess of the above is asked and all releases granted for other than military uses will be stamped:

"Released only upon condition that price does not exceed $1.50 per gallon in tank cars; $1.55 in drums."

The War Industries Board will be glad to have its attention directed to any demand for higher prices.

The President's Readjustment and Reconstruction Commission

A Vital Suggestion Relating to the Establishment of American Industry on a Sound Basis After the War—What Foreign Countries Are Doing—Necessity for Taking Care of Our Present Industrial Expansion

By WINGROVE BATHON,
Washington Representative, McGraw-Hill Co., Inc.

PEACE will come some day. In the meanwhile American industry is doing nothing whatever in an organized way to prepare for the necessary readjustment. On the other hand, England and her colonies, France, Italy, the Teutonic empires, the Far Eastern countries, and the Latin-American countries have begun to prepare for readjustment and reconstruction.

What must we do?

This article is for the purpose of suggesting the immediate creation of an agency to deal with the situation which will confront American industry at the end of the war, to gather facts now, to make plans now, to educate now, and to lead the industries of the country in the victories of peace when the right time comes.

In detail, this is to suggest that a great service would be done the American people, and perhaps all of the free peoples of the world, in view of the resources of the United States which must be drawn upon for a long period by the whole world after the war, if the President of the United States would appoint forthwith a commission, to be the President's own commission, to prepare for after-the-war problems. Such a commission should not be hampered by legislative enactments of Congress as to powers upon which it might be difficult for Congress to agree; not curbed and controlled by Government appropriations or the fear of lack of them. It should nevertheless be established under the Government sanction of an executive order, and should be assisted by the creation of an Advisory Council of Government officials and possibly the chairman of some committees of Congress. Many executive officials and legislators are themselves too busy with the work of the war to lay aside burdens of today to deal with after-the-war problems. Their assistants and associates should be used. As to the main commission, it should include not only leaders in industry of all forms taken from the ranks of private endeavor, but it should include leaders in labor, leaders in education, and leaders in every other endeavor which enters into industrial effort. Such a commission should report only to the President and should take as much of its inspiration from his leadership as he has time to give from the conduct of the war with which he is charged by the Constitution. Such a commission might very well include in its appointees the following:

Suggested Personnel of the Commission

E. H. Gary, President of the American Iron and Steel Institute; Samuel Gompers, President of the American Federation of Labor; Arthur N. Talbot, President of the American Society of Civil Engineers; C. P. Main, President of the American Society of Mechanical Engineers; E. W. Rice, President of the American Institute of Electrical Engineers; Sidney J. Jennings, President of the American Institute of Mining Engineers; Wm. H. Nicholls, President of the American Chemical Society; F. J. Tone, President of the American Electrochemical Society; A. G. Doan, President of the American Machine Tool Builders' Association; H. A. Wheeler, President of the Chamber of Commerce of the United States; P. H. Gadsden, Secretary of the American Electric Railway Association and Resident Washington Member of the Electric Railway War Board; S. G. Williams, President of the Highway Industries Association.

In addition there should be the presidents of some of the various national organizations occupied with production and manufacture in the lumber, leather, rubber, textile, glass and other great industries of the country; as well as perhaps the president of the Farmers' Grange, the president of a great railroad, the president of a great shipping company, the president of a great educational institution, the president of a great insurance institution, and perhaps the president of the American Bar Association and the president of the American Medical Association; but, in any case, and by all means, even if only to assure reports from abroad, the following representatives of American business in other countries:

A. V. Edwards, Secretary of the American Commercial Club of Argentina, Buenos Aires; Charles E. Lydecker, Secretary of the American Chamber of Commerce of Brazil, Rio de Janeiro; James R. Morse, Secretary of the American Chamber of Commerce in China, Shanghai; George M. Cassatt, Secretary of the American Chamber of Commerce in England, London; Charles H. Sherrill, Secretary of the American Chamber of Commerce in Paris, France; J. B. Stetson, Jr., Secretary of the American Chamber of Commerce in Italy, Milan; C. B. Parker, Secretary of the American Chamber of Commerce for Mexico, Mexico City; Preston M. Smith, Secretary of the American Chamber of Commerce for Spain, Barcelona; and Theodore R. Yangco, Secretary of the Chamber of Commerce of the Philippine Islands, Manila.

In Washington, the peace-time industries of the country are now being placed upon a war basis in a gradual manner. There has been time for a gradual "turning over" in the further organization of the war which has been proceeding steadily month by month. But when the industries of the country have been fully

placed upon a war-time basis, when supplies of labor, sources of material, reserves of capital and the markets for production have all been altered to meet war needs, it will be impossible to place industry back upon a peace basis gradually without danger of disaster second only in importance perhaps to the actual loss of the war.

To meet the danger there must be organized preparation, such as is now proceeding in all of the countries at war except the United States, and these suggestions are being made to set forth a working plan as a nucleus for discussion and action.

Similar Work Done by Foreign Countries

The facts and the prospects for the future are being discussed and acted upon in almost every country of the world except this. Literally thousands of books, pamphlets and other writings have been produced in foreign countries to educate the people along these lines. More than two years ago there was created in Great Britain a Reconstruction Committee, which has since become an agency of the British Government, the work now being in charge of Dr. Christopher Addison, a Minister in the British Cabinet without portfolio; and more than two hundred sub-committees plentifully supplied with experts are now engaged in solving British after-the-war problems.

The detail of what has been done in Great Britain and the other countries previously mentioned, and some suggestions as to what should be done toward readjustment in this country, will be offered in later articles.

After the war, because of accelerated thinking, we can secure the adoption of ideas that otherwise would not be acceptable, or would be acceptable only after a very lengthy educational process. Therefore we have an opportunity now, for, in addition to such obvious readjustment and reconstruction work as the orderly reintroduction to industry of returned soldiers, the development of export trade, and the use of our productive capacity for our industries expanded by war needs, we can use, now, the opportunity to secure the adoption by the people generally of economic theories such as the husbanding of our exhaustible natural resources, such as coal and other fuels, iron, timber, etc., and we can also bring about now the adoption of policies which will insure the perpetual renewal of even the so-called inexhaustible natural resources, such as the soil and its products.

Proposal for an Advisory Council

An Advisory Council for the suggested commission should be selected from those who are especially charged with the conduct of affairs vital to the industrial, commercial, transportation, labor, financial and educational worlds. Realizing the demands made by the war on chief cabinet officers, it should not be expected that they should serve actively on such a Council, although in one or two cases, such as that of William P. G. Harding, the Governor of the Federal Reserve Board, principal officials, rather than those second in command, ought to be selected. In the case of legislators, many chairmmen of Senate and House committees are also too much occupied with war legislation to deal now with after-the-war problems. Officials of executive departments on such an Advisory Council should be charged not only with the duty of giving advice and outlining governmental policies of the present and possible policies of the future, but should detail to the service of the commission experts in their own departments. In the following list, strict order of precedence and rank in the Government is not followed, but such an Advisory Commission or Council should include:

Frank Lyon Polk, Counselor for the Department of State, for all international contact;

F. M. Simmons, Chairman of the Senate Committee on Finance, for contact on future Government revenues and taxes;

Claude M. Kitchin, Chairman of the House Ways and Means Committee, for contact on future Government revenues and taxes;

Duncan U. Fletcher, Chairman of the Senate Committee on Commerce, for contact on legislation affecting commerce;

Thetus W. Sims, Chairman of the House Committee on Interstate and Foreign Commerce, for contact on legislation affecting commerce;

Gilbert M. Hitchcock, Chairman of the Senate Committee on Foreign Relations, for contact on future international legislation;

Henry D. Flood, Chairman of the House Committee on Foreign Affairs, for contact on future international legislation;

John Bassett Moore, Vice Chairman, United States Section, International High Commission, for contact with international law, patents, trade-marks, etc., in Latin America;

John Barrett, Director General, Pan-American Union, for Latin American contact in detail;

William P. G. Harding, the Governor of the Federal Reserve Board, and Charles S. Hamlin, President of the Capital Issues Committee, and Sherman Allen, Treasurer of the War Finance Corporation, for contact on finance;

E. R. Stettinius, Assistant Secretary of War, for contact in industrial war production; and Rear Admiral Samuel McGowan, Paymaster General of the Navy, for contact on industrial naval production;

Maj. Gen. E. H. Crowder, Provost Marshal General, for contact on reintroducing returned soldiers to industry;

William H. Taft and Frank Walsh, Chairmen, War Labor Board, for contact with war labor problems and activities;

John A. McIlhenny, President, Civil Service Commission, for contact on Government employment;

Carl Vrooman, Assistant Secretary of Agriculture, for contact with the soil and its agricultural products;

Edwin F. Sweet, Assistant Secretary of Commerce, for contact with the Census and other Bureaus dealing with commerce;

William B. Colver, Chairman of the Federal Trade Commission, for contact with the coming administration of the Webb Act which permits combinations for foreign trade and for contact on unfair practices under the Newlands Act;

F. W. Taussig, Chairman, United States Tariff Commission, for contact on material now being gathered by Commission on after-the-war problems;

Raymond B. Stevens, Vice Chairman, United States Shipping Board, for contact on tonnage available after the war;

Herbert Hoover, United States Food Administrator, for contact on food licenses during reconstruction period and possible repeal of laws;

H. A. Garfield, United States Fuel Administrator, for distribution of coal and oil and possible repeal of laws during and after reconstruction period;

Walker D. Hines, Assistant to the Director General of Railroads, for contact with transportation and terminals after the war;

A. Mitchell Palmer, Alien Property Custodian of the United States, for final disposition of enemy-owned plants and other property;

Bernard M. Baruch, Chairman of the War Industries Board, for contact on sources of supply of raw materials and finished products;

Walter S. Gifford, Director of the Council of National Defense, for contact on reviving less essential industries;

Vance C. McCormick, Chairman, War Trade Board, for contact on licenses for imports and exports after the war;

Executive Secretary (when named) of the Water Power Commission of Cabinet Officers which is about to be created;

Daniel C. Roper, Commissioner of Internal Revenue, for contact on collection of excess profits taxes, etc.;

Charles D. Walcott, President, National Academy of Sciences, for Government contact with the sciences;

Charles F. Nesbit, Division of Military and Naval Insurance, for contact on personal insurance problems and defectives on his rolls who are returned soldiers;

Philander P. Claxton, Commissioner of Education and Secretary of the Federal Board for Vocational Education, for contact on educational statistics and statistics on defectives;

George Creel, Chairman, Committee on Public Information, for assistance and contact in educational work.

It is respectfully submitted that this is no mere list of names. Broadly speaking, it is an analysis of the industrial war organization of the United States, and a reading of the suggested contacts will show that the work of these officials, and that of their departments, bureaus and associates, will be just as vital to the solving of the after-the-war problems as it is vital to winning the war now. The two problems cannot be separated. All national contacts today are international. We think and move in terms of world-wide importance.

Industrial Changes Created by War

After four years of war, England has found it necessary to tear up and move to France between fifteen and twenty per cent. of her main line tracks. If the war lasts a long time, if there is not iron enough, if there is not steel enough, if there is not labor enough, if there is not constant maintenance, something like that might happen in this country. Then there will be need for actual physical reconstruction in this country, as there is abroad, instead of need merely for readjustment. Plans for such possibilities must be made now. Again, it is estimated that we shall have within a year forty-five to fifty million tons of steel-ingot-producing capacity and probably one hundred per cent greater finishing-machine-producing capacity than we had in 1913, in which year we were obliged in many lines to go abroad for a market for our surplus production. What plans are in the making for our surplus production after the war? Again, it is estimated that we shall have, with what we now have, 15,000,000 tons in merchant ships available after the war. What definite trade routes from American ports to the other ports of the world are being thought out?

No Central Government Agency Ready with Information Desired by Industry

The biggest American business which has been built up abroad has been in machine-finished steel products, such as talking machines and music machines, cash registers, agricultural machinery, adding machines, sewing machines, etc. Plans must be made to introduce these special products. One company now represented in Washington desires to open an office at Rio de Janeiro; another desires to send 600,000 tons of shipping to Australia next year. Is there any governmental agency or semi-governmental agency in Washington to offer encouragement or authoritative advice? No. What is being done to divert to American ports the rehandling business previously done in Europe, such as the bringing of rice from India, to reclean it, regrade it, and reship it; what is being done to hold for the United States the rubber now coming here to avoid two trips through the submarine zone which formerly went to England; what is being done to hold for the United States the business in tin which formerly went to England and Holland from Bolivia; what is being done to hold for the United States the business in coffee which originally went almost entirely to Europe, at which time we paid for the longer freight haul and commissions in London, Hamburg and Bremen, and much of which now comes to this country?

An Advisory Council such as has been outlined in this article, working with the proposed President's Readjustment and Reconstruction Committee or Commission, could answer these questions, if answers are in existence; and if not, could place industry through the Commission in a position to meet such problems as have been suggested, and a thousand more. The United States Tariff Commission is one of the few governmental agencies which is avowedly gathering data for after-the-war problems. The Federal Trade Commission, the Department of Commerce, and the War Trade Board are also collating some information. But there is no apparent co-ordination of these efforts, such as there is in England and other countries. The next article in this series will deal with what is being done in that respect in England.

Chemical Engineers Meet This Month

The summer meeting of the American Institute of Chemical Engineers will be held at Gorham and Berlin, N. H., Wednesday, June 19th to Saturday, June 22nd.

The following papers will be read and discussed:

The Human Element in the Mill, by Hugh K. Moore.

Maintenance, Construction and Organization of Sulphite Mill, by Walter H. Taft.

The Seeding Method of Graining Sugar, by H. E. Zitkowski.

The Manufacturer and Fuel Situation, by Wm. H. Booth.

War Pyrotechnics, by G. A. Richter.

Food Conservation by Edw. Gudeman.

Chemical Stoneware and its Properties by A. Malinovszky.

Symposium on the Coal Tar Industry; Expansion of the Coal Tar Industry in the United States by F. E. Dodge.

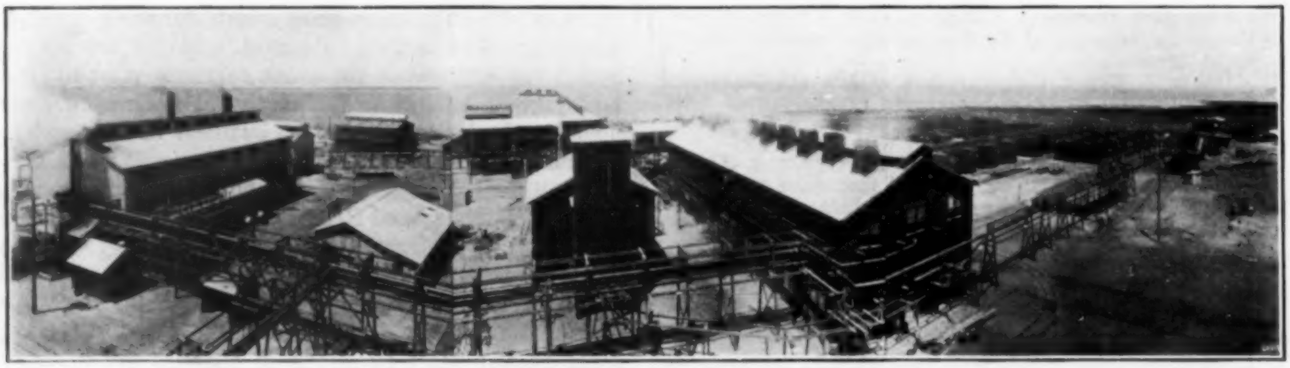
Expansion of the By-product Industry of Coal and Water Gas Plants in the United States by W. M. Russell.

Manufacture of Phenol by A. G. Peterkin.

Multiple Tangent System for the Manufacture of Sulphuric Acid by L. A. Thiele.

The following plants of the Brown Company will be visited under the leadership of Mr. Hugh K. Moore: The sulphite mill, the largest in the world; the saw mill and photographic department; the Cascade paper mill; the chemical plants, including electrolytic and caustic plants; fibre tube mill, carbon tetrachloride plant, chloroform plant and hydrogenated oil plant.

A joint meeting with the local section of the American Chemical Society will be held on Wednesday evening at the Mt. Madison House, Gorham, N. H. A unique feature of the program will be an entertainment by the employees of the Brown Company. Headquarters will be at the Mt. Madison House, Gorham, N. H.



The California Kelp Operations of the Hercules Powder Company

An American Industry Developed as a Result of a Demand for Acetone for Use in Munitions. An Example of American Chemical Engineering and Research Applied to a Pioneer Project

THE giant kelp of the Pacific Coast has provided a good deal of material for dreams and almost a hurricane of gossip, but detailed information of the industrial production of potash or anything else from this source has been scarce. Long lists of the botanical names of the various species of kelp have been published, and alluring notes on the K_2O content of dried material, showing amazing variations, have been recorded; but when engineering details were given, it has often happened that the information was inspired by some promotion scheme. On the other hand, time and again the possibilities of this kelp in industry have been made evident and our curiosity has grown alert to discover the actual progress of industrial research in the matter.

A little over a year ago Mr. H. L. Glaze of Los Angeles predicted in an article in this journal[1] that the crowning achievement along kelp-potash lines would be that of the Hercules Powder Co. on the bay at Potash, near San Diego. Other concerns have built plants and some seem to be succeeding, but the Hercules works at Potash are the largest of all and we are now in a position, thanks to a number of gentlemen connected with the company as its officers, to give a record of its achievements in research and industry.

It is interesting to note that the growth of this great undertaking and the working out of the processes have followed along different lines from those of others working in the same field. It was designed and built because the Powder Company had a contract to furnish the British Government a large quantity of powder, but the British Government did not want the Powder Company to compete against it for the large quantity of acetone required for the purpose. To complete the contract a new source of acetone had to be found and the Hercules people immediately began an exhaustive study of kelp with this in view. The results were very promising and in February, 1916, ground was broken for the works. By Fall of the same year the plant was completed and running. Thus the need of acetone was the main reason for establishing the plant, while the potash and many of the chemicals which have been produced may be classed as subsidiary products, although large in tonnage.

Extensive Research Required

A great amount of research has been done by the company in the development of this undertaking; indeed a large number of both research and control chemists have been required from the start. In providing harvesters it has demanded the highest order of engineering skill and ingenuity to design or to adapt equipment to uses previously unknown to meet the unusual problems. New questions in practice arose daily and these had to be solved immediately or the operation of the plant would be interrupted.

As the fruit of intense research and untiring engineering application, the plant is now producing in substantial quantities, muriate of potash 95 to 98 per cent pure and practically free from sulphate, acetone that tests

FIG. 2. HARVESTING KELP

[1]Potash from Kelp in Southern California, April 1, 1916, p. 355 et seq.

better than the stringent specifications of the British Government, iodine U. S. P. and ethyl acetate meeting all the usual commercial specifications. In addition to all these well known chemicals, the works are producing ethyl propionate and ethyl butyrate on a scale never before approached. These latter solvents are especially interesting as amyl acetate substitutes on account of the efforts which the U. S. Government is now making to conserve acetate of lime.

General Features of the Project

The plant shown in the general view, Fig. 1, is located on the bay at Potash, near San Diego. Over $5,000,000 has been spent in its construction and operation, and it covers about 30 acres. It uses about 6000 boiler horsepower and approximately 1000 men are employed, including from 75 to 100 at sea on harvesting work. Chemical control involves from 1500 to 2000 tests daily. The research staff numbers from 15 to 20 and this work is housed entirely separate from the control laboratories. The company is cutting about three-fourths of all the kelp cut on the Pacific Coast. In 1917 it averaged about 24,000 tons per month.

Harvesting the Kelp

This is the first step in the process. The designing of harvesters began as soon as the plant was started. Although about 100 patents had been taken out by other inventors, no really efficient design of harvester for large-scale work existed at that time. The system which has proved satisfactory consists in a combination of harvesters, barges and tugs. Fig. 2 shows a harvester in operation, with the freshly cut kelp carried up from the water by moving screens. From the screens it passes through macerators and thence into the hold of the harvester vessel and from this point it is pumped through a pipe boom to a barge, as shown in Figs. 3 and 4. The cutters or harvesters are ocean-going boats and stay out at sea all the time, while the barges carry the macerated kelp back to the wharf where it is pumped from the holds into fermenting tanks which are shown in the general panorama in Fig. 1, and also in Figs. 6 and 7. Pumping kelp was a problem at first but it was solved by a model of a Goulds rotary pump. Foreign matter such as bolts, nuts, etc., brought in with the kelp are removed by electromagnets before the pumps are reached.

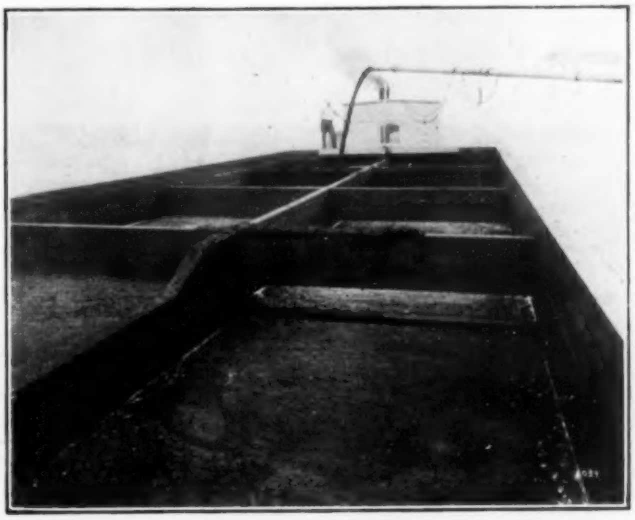


FIG. 4. BARGE BEING FILLED WITH KELP

Harvesting consists in cutting the plant about six feet below the surface of the water. It has actually been found that this treatment improves the growth and stand of the beds to such an extent that they may be cut over about every ninety days. The area cut at present extends from Pt. Conception south to the Mexican line.

Fermentation of Kelp Pulp

After it is pumped to the redwood tanks shown in Figs. 6 and 7 the kelp is diluted to a certain point and allowed to ferment under the correct temperature conditions. This unit is believed to be the largest in the world and comprises over 150 tanks of 25 ft. diameter, holding 50,000 gal. each. Each tank is equipped with hot-water coils for temperature regulation and compressed-air pipes are arranged to provide the proper agitation. Railroad tracks are laid between the batteries of tanks, and here Brownhoist locomotive trains are operated to load material upon the bridges which connect the tanks. Fermentation takes from ten days to two weeks and sometimes more. The organic acids, acetic, butyric, propionic, etc., are formed during the process and, by the addition of lime, their respective calcium salts are produced. These go into solution together with the potash and other soluble salts which are

FIG. 3. PUMPING KELP FROM HARVESTER TO BARGE

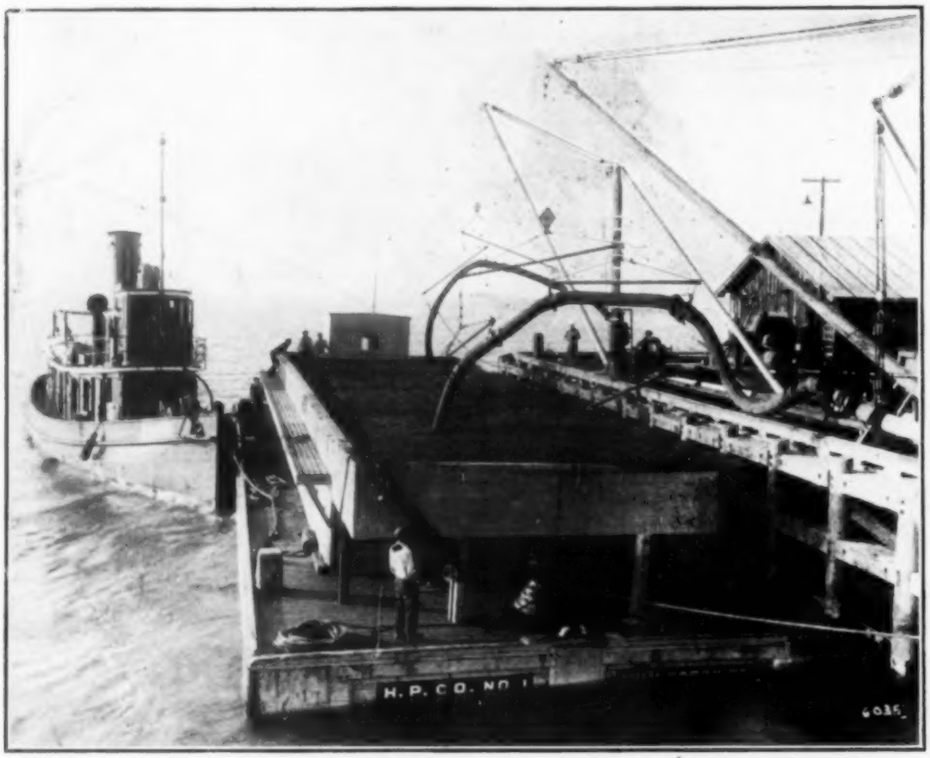


FIG. 5. DISCHARGING A BARGE-LOAD OF KELP

released as the fermenting process breaks down the cells of the kelp.

Separation Processes

After the fermenting period the resultant liquor is screened to remove undigested matter, following which the solution is allowed to settle. It is then filtered. The clear liquor contains potassium and sodium chlorides and the calcium salts of various fatty acids, but chiefly of acetic, butyric and propionic. The filter press building is shown in Fig. 8 with the Oliver press in the background and the two Kelly presses to the fore. The residue left from screening is still waste, and is discharged as refuse.

Evaporation is conducted in quadruple effect Kestner vacuum evaporators, shown in Fig. 9. They are operated with exhaust steam at a maximum pressure of 5 lb., and with a vacuum of about 26 inches. Triplex plunger pumps are used at this point. The principal trouble in evaporation has been to keep the evaporator tubes free from scale. After evaporation to a certain point the liquors are allowed to crystallize, and the first product to come to the top is a mixture of the calcium salts of the fatty acids, which from its nature has been named "taffy." This taffy is removed and subsequently made into high-grade solvents. The next body to crystallize is calcium acetate, which contains some potash, and at this point the liquor is removed and cooled. Then the bulk of the potash comes down as 95 to 98 per cent pure potassium chloride. A view of the lower floor of the crystallizing house is shown in Fig. 10. The salt chambers and cone bottoms of the cold kettles are shown on the left and the hot kettles to the right. Fig. 11 shows the upper floor of the same building with the same arrangement: cold kettles on the left and hot kettles on the right.

Later Treatment of Crystallized Products

As stated above, the taffy, which is obtained as the first product, contains salts of fatty acids of the acetic series. It has been found possible, after considerable research, to make from this such products as ethyl butyrate, ethyl propionate, etc., and methyl-ethyl-ketone as well as higher ketones, on a considerable scale. This is a noteworthy development inasmuch as it opens up a new source of supply of high-grade solvents which heretofore have been made entirely from calcium acetate. In fact, the solvent situation has been so serious that the U. S. Government has placed restrictions upon the use of calcium acetate. This development of an entirely new supply of solvents will surely be welcomed by important chemical industries which depend for their

FIG. 6. TANK FARM FOR FERMENTATION OF KELP

FIG. 7. INTERIOR VIEW OF TANK

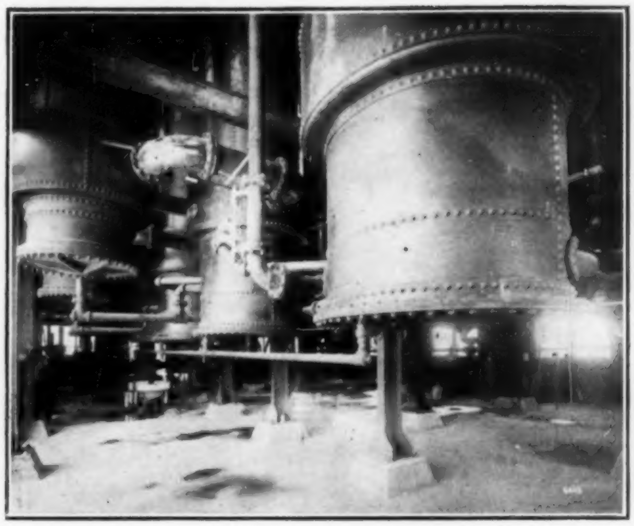


FIG. 9. LOWER FLOOR OF EVAPORATOR PLANT

existence on a constant supply of standard solvents such as ethyl acetate, amyl acetate, etc. Indeed, it seems probable that for the first time in the history of chemical industry, a practical supply of ethyl butyrate and propionate is placed within reach. These esters, being almost identical in physical characteristics, more particularly in regard to their boiling points, solvent power, freedom from residual odors, etc., form very desirable substitutes for amyl acetate and other solvents of a like nature.

The next product, calcium acetate containing some potash, is used to produce acetone, while the residue from distillation contains potash and the iodides. This is further separated with the production of high-grade iodine and more potash (chloride), which, like the product of the first crystallization, runs above 95 per cent in purity and is practically free from the sulphate. All potash is carried from the salt chambers to the centrifugal building by side-dump buckets, where they are elevated to Tolhurst centrifugals. After centrifuging the crystals are dried in steam-jacketed rotary dryers and then sacked and are ready for shipment.

The Finished Product

A feature of singular interest is the purity of these kelp products. It is fair to say that these results have become possible only after long and arduous research; that the separations of the organic esters are difficult and that the work involved great experimentation. The field was new and processes and apparatus had to be established and designed *de novo* to meet some conditions while standard apparatus had to be radically rearranged to meet others. Indeed, these difficulties presented themselves at every step in the organization of the plant. Ethyl acetate and ethyl anhydride are also made, the latter being used to produce cellulose acetate for noninflammable aeroplane dope.

FIG. 8. INTERIOR OF FILTRATION PLANT

The potash is all used for chemical purposes, owing to its unique purity, and there is not enough of it to supply this demand. The total quantity of the pure product is not great enough to be considered seriously for fertilizer purposes. There are, however, a number of residues produced which contain potash which amount to quite a tonnage and these offer interesting and attractive possibilities in which fertilizers are to be considered. Research is in process in regard to these residues. To the chemical trade, however, the products of special interest are the 95-98 per cent KCl and the organic solvents.

Everything points to the permanency of this industry.

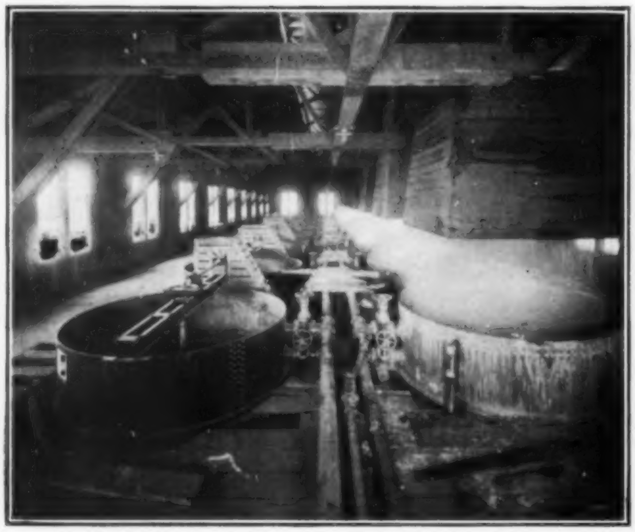


FIG. 11. UPPER FLOOR OF CRYSTALLIZING HOUSE

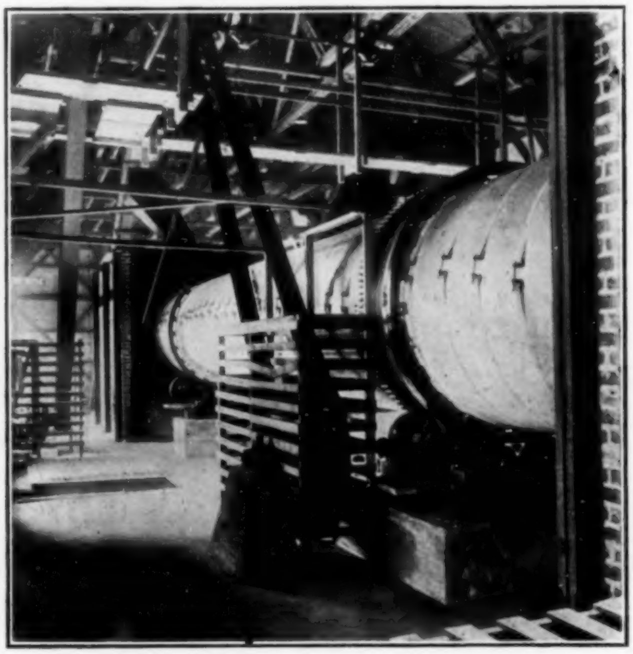


FIG. 12. ROTARY DRYER FOR POTASH

The statements published as to the amount of potash, iodine and other constituents of kelp and as to the quantity of the available kelp itself have, as a rule, been greatly exaggerated. It is doubtful if this will ever be a really important source of fertilizer potash for which, although the quality is not important, an immense tonnage is required. At this establishment, the promise of permanence lies in the quality of its products. After the war demand ceases, the chemical industry will surely want the KCl for the production of potash salts; and the solvents have long been needed.

The company plans to have a comprehensive exhibit showing the various stages of the work and samples of its products at the Fourth National Exposition of Chemical Industries which will be held in New York City next September.

The British Nonferrous Metal Industry Act.—This act is characterized by *Commerce Reports* as marking another step in British preparations for trade after the war of almost equal importance with the Imports and Exports Bill. Its effect cannot be predicted owing to the broad discretionary powers vested in the Board of Trade. All houses carrying on the "business of winning, extracting, smelting, dressing, refining or dealing" in more than 25 tons of zinc, copper or lead quarterly, or more than 5 tons of tin, nickel or aluminium, metal, scrap, or ore must be licensed. The Board of Trade may refuse licenses to houses to which any one of six conditions apply, one of which, the most inclusive, is: "That the company, firm or individual is by any means whatever, subject, directly or indirectly, in the conduct of their or his business to enemy influence or association." Companies must recall all unregistered stock carrying voting power in the management. The applicant for license must furnish detailed information as to the names and nationalities of all officers, shareholders and members, the location and management of foreign branches, and declarations as to any connection with enemy firms dealing in nonferrous metals and ores.

The act is unusually broad and will have a large influence in determining post-war conditions in Great Britain.

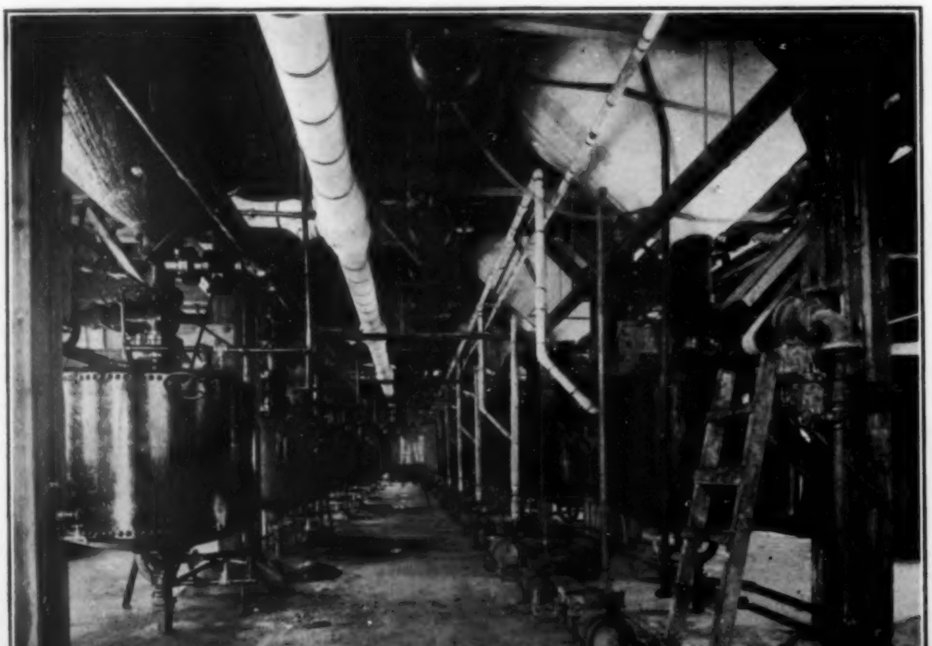


FIG. 10. LOWER FLOOR OF CRYSTALLIZING HOUSE

Electrochemistry and National Economy*

BY COLIN G. FINK

THE American Electrochemical Society considers itself very fortunate indeed to have been afforded the opportunity of undertaking this most interesting and highly instructive trip through the Appalachian South. What we have already seen more than convinces us that the Appalachian South is rapidly developing into one of the leading industrial centers of the world. We electrochemical engineers look upon Muscle Shoals as the new Niagara, the Niagara of the South! What constitutes an electrochemical industrial center? What are the essential requisites? What are the raw materials necessary for the production of that long list of metals, alloys, carbides, fertilizers, explosives, abrasives, lubricants, solvents, refractories, disinfectants, electrodes, and gases for cutting and welding? The first essential is an abundant supply of cheap power—power to be had in large blocks for 24 hours a day and 365 days a year! Cheap power is almost always synonymous with water power—and of this the Appalachian South has been supplied by nature in gracious abundance. In the state of Tennessee alone, according to the estimates of Prof. J. A. Switzer, there are available almost one million horsepower. In other words, Tennessee alone has enough power available to foster an electrochemical industry twice the size of that existing at Niagara Falls today!

NITROGEN-FIXATION PLANTS IN THE SOUTH

When our Government decided to establish the nitrogen fixation industry in this country and considered the various localities suitable for the electrochemical production of those most vital compounds, ammonia and nitrates—without which we could neither feed our populace nor defend our borders—our Government, after due deliberation, most wisely decided to erect the "air saltpeter" factories at Muscle Shoals, Alabama. Therefore as regards the supply of cheap water power in the Appalachian South there is no doubt. Careful surveys have reported a vast abundance. In this connection it is gratifying indeed to note that the United States Chamber of Commerce, comprised of 500,000 business executives from every state and territory in the country, unanimously adopted resolutions calling on Congress to make provisions for harnessing the millions in water horsepower that are now going to waste.

The development of our water-power resources is of prime national economic value. It means the saving of coal and oil, which though most abundant here in the South are nevertheless exhaustible, and once used can never be replaced. It means the saving of railroad equipment now used for the transportation of coal and oil; it means the saving of a long list of valuable chemical products now burned and wasted under thousands of boilers; and it means the saving of millions of dollars in labor. The water power generated in the Province of Ontario, Canada, has reduced coal consumption between 5,000,000 and 6,000,000 tons per annum. Under fairly efficient working conditions it requires from 2 to 6 pounds of coal to generate power equivalent to one horsepower-hour. Think of the tons and tons of coal represented by the available water power of this country, which is estimated by the Geological Survey at 32,000,000 hp. minimum potential.

THE BY-PRODUCT VALUE OF COAL

The electrochemist looks upon the vast coal resources of the Appalachian South as intended for purposes of greater economic value. The coal reserves of a single state, West Virginia, have been calculated at 150,000,000 tons. The southern coal makes the best coke, and very valuable by-products are thereby conserved. Alabama is second largest coke-producing state in the country. Tons of coke are shipped from the South to Niagara Falls and there heated in contact with sand in large electric furnaces that produce temperatures that are higher than can be attained in any other way. A beautiful crystalline product is obtained, carborundum, a silicon carbide, an abrasive which has found world-wide application. Another important electrochemical product largely dependent upon Appalachian coke is calcium carbide. This was first made by Willson at Spray, North Carolina, by mixing ordinary limestone and coke and heating to very high temperatures in the electric furnace. Calcium carbide is the source of acetylene, which is used in conjunction with electrolytically produced oxygen in the oxy-acetylene torch for steel welding and steel cutting. You are all familiar with this time and labor-saving device! Calcium carbide furthermore serves as the "raw material" in the electrochemical manufacture of cyanamide, which the Government will soon be turning out by the ton at Muscle Shoals. It is a very efficient fertilizer. Another and very recent by-product of calcium carbide is acetone, consumed in large quantities in the manufacture of explosives. There seems to be no end to the list of compounds and products of inestimable worth that are all primarily derived from Appalachian coke.

ALUMINUM AND ABRASIVES FROM BAUXITE

The South has been most strikingly favored by nature in the line of raw materials for electrochemical products. Next in importance to her coke resources are her extended deposits of bauxite, the basic mineral from which that metal of many uses, aluminium, is derived. The aluminium industry of this country ranks among the very first and consumes almost as much in kilowatts as all the other electrochemical industries put together. There are but four states in the whole country that have been mining bauxite in commercial quantities—Arkansas, Georgia, Alabama and Tennessee. In 1917 these states turned out 400,000 metric tons of bauxite, which is 12 per cent more than the world's bauxite output of the year 1910. The Aluminum Company of America has a large metal-producing plant at Maryville, Tennessee. This appears to us as a very wise move. Why ship bauxite by freight hundreds of miles away? Why not make the metal near the source of the raw material? It requires 2 tons of bauxite for one ton of aluminium metal.

Bauxite is also used for the manufacture of aloxite and alundum, artificial emeries of great hardness and uniformity which are made in electric furnaces at Niagara Falls. The artificial abrasives, alundum, aloxite and carborundum, have practically replaced imported emery and corundum. These electric furnace abra-

*Presidential Address, 33rd General Meeting, American Electrochemical Society, Knoxville, Tenn., April 30, 1918.

sives have virtually revolutionized the machine shops, doubling and trebling their output.

An electrochemical industry which is most typically American is the electrolytic copper refining industry. Over 75 per cent of the copper consumed today is purified and refined by electrochemical methods; it is of the highest attainable quality, exceeding in purity Sterling silver. The largest electrolytic copper plant in the world is located at Canton, Maryland, with an annual production of 720,000,000 pounds. The modern electrical industry with its dynamos and motors, its telephone, telegraph and wireless and its countless electromagnetic devices would be helplessly crippled if we were to deprive it of electrolytic copper.

In the electric steel industry the United States likewise leads the world. The quality of electric steel surpasses that of the best crucible steel. Next to Minnesota and Michigan, Alabama is the largest iron-producing state in the Union. Over 50 per cent of the iron ore reserves of the U. S. are located here in the South.

Closely linked with the electric steel industry is the ferro-alloy industry—Ferromanganese, ferrosilicon, ferrochromium, ferrotitanium and others. Ferrosilicon and other ferro-alloys are electrically made by the Southern Ferro Alloys Co. at Chattanooga, Tennessee. Electric ferromanganese is made by the Southern Manganese Corporation at Anniston, Alabama.

Deposits of manganese occur in many parts of the United States but are most abundant in the Appalachian and Piedmont region, Virginia and Georgia being the largest producers. Silicon is derived from quartz rock and sand. Titanium is derived from the mineral "rutile." For many years the sole producer of rutile in this country has been the American Rutile Company whose plant is at Roseland, Virginia. Rails made of steel to which ferrotitanium was added during the process of manufacture, are less liable to breakage and are 40 per cent more durable than are ordinary open-hearth rails. Another electric titanium alloy is cuprotitanium, containing 10 per cent titanium and 90 per cent copper. This is extensively used in making sound castings of copper and bronze.

Carbon bisulphide is a solvent upon which the rubber industry is very much dependent. Formerly it was made by long tedious and expensive processes. Today all carbon bisulphide is made electrochemically. The raw materials are charcoal and sulphur. The great sulphur states of the world are Louisiana and Texas. The combined output of these two states exceeds not only that of all other states put together but that of all the rest of the world. One of many wells of the Union Sulphur Company discharges 500 tons of sulphur per day.

Modern Versus Earlier Processes

If we arrange the electrochemical industries according to the number of factories and the total power consumed, both in this country and abroad, we find that the electrolytic alkali and chlorine industry ranks fourth in the list. What a long array of interesting and important products have been developed and turned out by the ton by this industry: caustic soda and bleach, chlorine gas, sodium metal, disinfectants and peroxides and a series of valuable compounds! The basic raw material is common salt, NaCl, and it is interesting to note that Virginia is sixth largest salt-producing state in the country. The electrochemist takes this salt, dissolves it in water and passes a current of electricity through the solution. How simple is this electrolytic method compared to the old fashioned process of producing alkali and chlorine, according to which you had to start out with pyrites or sulphur, oxidize this to sulphuric caid, add this acid to salt thereby liberating hydrochloric acid; then taking this acid and treating it with manganese peroxide to "free" the chlorine gas; the sodium sulphate, obtained by adding the sulphuric acid to sodium chloride, was dried, mixed with coke and limestone and transformed by heat into calcium sulphide and sodium carbonate; finally the sodium carbonate was dissolved in water and boiled with lime producing sodium hydrate or alkali. We certainly need not emphasize that electrolytic alkali spells economy. Think of all the labor and power that is conserved!

One of the most recent achievements of the electrochemist is the commercial production of electrolytic tin. Unfortunately, outside of Alaska, our country has no large tin deposits. The electrolytic tin refining plant at Perth Amboy derives practically all of its ore from Bolivia. However, during recent years our government has undertaken an earnest search for tin in this country and it is gratifying to read the recent report of the U. S. Geological Survey on promising deposits developed in the Kings Mountain and Lincolnton districts, North Carolina and in Rockbridge County, Virginia. So that it seems if we are to have any tin industry at all it will be here in the south.

Truly, nature has been most lavish with her treasures here in the South and the electrochemical engineer finds in this region, rich in natural resources, water power, iron, coal, phosphates, manganese, aluminium, titanium, quartz, salt, copper, pyrites and limestone, the most ideal localities for the founding and fostering of important electrochemical centers.

Instructors Wanted for Engineers Training School

The Government proposes to establish immediately at Camp Humphreys, Va., a training school for replacement troops of the Engineer Corps. These men will be given intensive training to fit them for the special service required in connection with the various engineer units in the service. A complete school in which all the trades as identified with the engineer units of the Army will be taught by means of short intense courses.

As this school will have an ultimate capacity of approximately 30,000 men, many instructors will be required and an appeal is made to the qualified men beyond the draft age who are willing to volunteer their services and enlist in the Engineer Corps as instructors in this school. The requirements are: a thorough knowledge of the following branches—machinists, blacksmiths, wheelwrights, carpenters, concrete foremen, electricians, dynamo experts, miners, painters, riggers, sheet metal workers, foundrymen, automobile and motor trucks, gas engine men, draftsmen, photographers and general foremen of construction.

Full particulars and application blanks will be furnished by applying to Captain Louis T. Grant, E.R.C., Secretary, Engineer Training Schools, Camp Humphreys, Va.

A Rocking Electric Brass Furnace

A New Type of Arc Furnace Developed by Metallurgists of the U. S. Bureau of Mines—Comparison with Other Types—Record of Comparative Tests with Coke-fired Furnaces—Power Consumption and Costs

BY H. W. GILLETT AND A. E. RHOADS

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IT SEEMS inevitable that the next few years will see electric furnaces largely replacing crucible furnaces in the brass industry; a development comparable to that which the last few years have seen in the steel industry.

With Klingenberg clay not available, and Ceylon graphite requiring ships needed for other purposes, crucibles, despite the good work done by crucible manufacturers, the Bureau of Standards, and others on the problem, are, speaking generally, still of much poorer quality, and many times more costly, than they were under pre-war conditions. The time is ripe for the practical elimination of the crucible from the brass industry.

With the huge tonnage of brass required for war purposes, the use of the small units—averaging 200 lb. per charge—in which crucible melting is done by the brass rolling mills, seems, and is, an anachronism. Besides the avoidance of crucibles and the ability to melt larger charges, electric melting (in a suitable type of furnace) decreases the loss of metal by oxidation and volatilization, prevents the taking up of sulphur from the fuel, gives better and more healthful working conditions, and has many minor advantages such as freedom from handling and storing fuel and ash. Electric furnaces give crucible quality of metal without using crucibles.

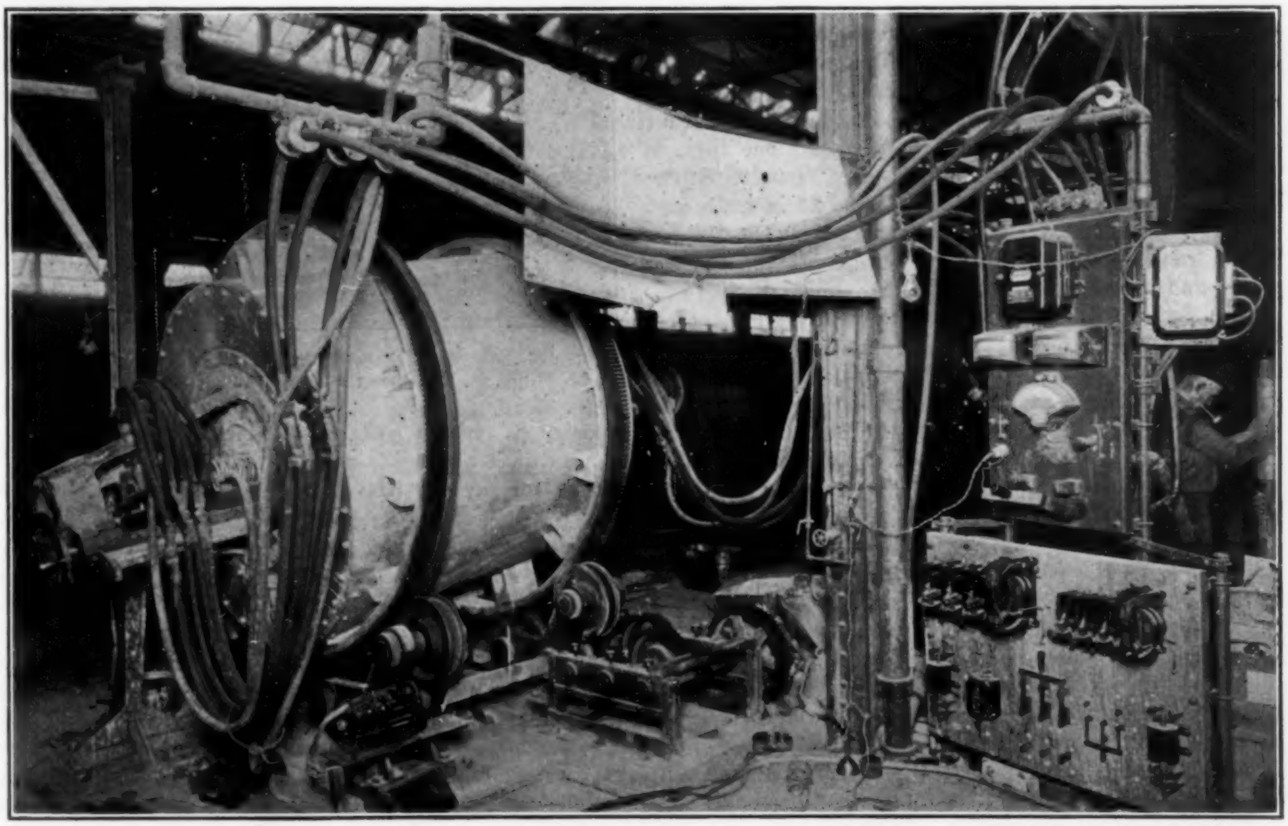


FIG. 1. REVOLVING ELECTRIC BRASS FURNACE AT MICHIGAN SMELTING & REFINING CO., DETROIT

BRASS MELTING REQUIRES FURNACES OF SPECIAL CHARACTERISTICS

However not every type of electric furnace can be used for brass melting. If brass did not differ materially from steel in its behavior during melting, electric furnaces would long ago have superseded crucible furnaces. But brass is made up of copper and zinc, and zinc is volatile at brass melting temperatures. For this reason, fuel-fired furnaces of the reverberatory type can be applied to brass only at the expense of a zinc loss so high as to prohibit the procedure. Similarily, the direct-arc type of electric furnace used for steel melting, such as the Heroult, can be used only on bronzes practically free from zinc, because of the high local temperature of the melt under the arc.

Indirect-arc furnaces, such as the Rennerfelt, can be used on brasses carrying up to about 20 per cent zinc, but are not suitable for ordinary yellow brass, on account of the formation of a superheated layer on the surface of the melt directly under the arc, and the resulting volatilization of zinc.

Induction furnaces of the ordinary horizontal-ring type, like the Rochling-Rodenhauser, cannot be used on brass or bronze because the high electrical conductivity of these alloys requires a secondary current so high that the "pinch effect" causes rupture of the secondary ring.

Hence it has been necessary to develop types of furnaces radically different from those in use for steel in order to meet the requirements of brass.

Electric Brass Furnaces in Commercial Use

There are, however, two types of steel furnaces which have been applied to brass (using the term brass loosely to include bronze, red brass, etc.), the Snyder, a single-phase direct-arc furnace, and the Rennerfelt, a two-phase indirect-arc furnace. At the Chicago Bearing Metal Company, Chicago, Ill., two one-ton Snyder and two one-ton Rennerfelt furnaces are melting bronze for railroad bearings, high in lead, but practically free from zinc. The metal losses are not much reduced from previous practice in crucibles and open-flame oil furnaces, but the furnaces are making savings in melting cost as compared with either the crucible or the open-flame furnaces under present conditions.

The Philadelphia Mint is melting nickel and coinage bronze in a 1000-lb. Rennerfelt furnace. The Gerline Brass Foundry Company, Kalamazoo, Michigan, melts Monel metal, red brass and brass containing up to about 20 per cent zinc in an 800-lb. Rennerfelt. The furnace at the Gerline plant is run on a 9-hour basis, while the other furnaces mentioned operate 18 to 24 hours a day.

Two other types of furnace designed especially for brass melting, have also found commercial use, the Baily and the Ajax-Wyatt.

The Baily furnace uses a single-phase granular resistor, the heat from which is reflected down onto the hearth from the roof. It takes charges of about 1000 lb. Baily furnaces are installed at the Lumen Bearing Company, Buffalo, N. Y., Hays Mfg. Co., Erie, Pa., Bridgeport Brass Co., Bridgeport, Conn., and the Baltimore Copper Smelting and Rolling Company, Baltimore. Md. The Baily furnace is applicable to alloys of any zinc content, reduces metal losses, avoids crucibles, and gives good working conditions. The main drawback of this type of furnace is that the source of heat is not close to the melt and the heat must be reflected down from the roof. In order not to overheat the roof and cause its prompt failure, as well as to hold the resistor temperature within the limits that allow reasonable life of the resistor trough, the rate of power input is low compared to the size of the furnace and weight of charge. Hence the radiation losses from walls and roof form a large proportion of the total power. The furnace is at its best on 24-hour operation. When 10-hour operation is necessary, it is found that the furnace must be heated empty during all or part of the night in order to give satisfactory output in the daytime. Because of the high heat storage in the walls, a furnace of this type does not respond promptly to changes in power input, and accurate control of the temperature of the melt is difficult.

The Ajax-Wyatt furnace is a single-phase induction furnace in which the secondary ring is in the form of a loop below the level of the hearth proper, so that the hydraulic head of the metal in the hearth opposes the rupturing effect of the "pinch" force, thus avoiding the troubles that make horizontal-ring induction furnaces inapplicable to brass.

The metal heated in the secondary loop is constantly ejected at one part of each opening from loop to hearth, and colder molten metal drawn in at another part of the opening. These fountains of hot metal issuing from the resistor melt the charge in the hearth. The constant circulation of metal is a most desirable feature and gives a product of remarkably uniform chemical composition.

Because of the compactness of the furnace, the generation of heat within the metal itself, and the stirring action, vertical-ring-induction furnaces are extremely efficient as regards power consumption. The power factor, in the sizes so far built, is satisfactory.

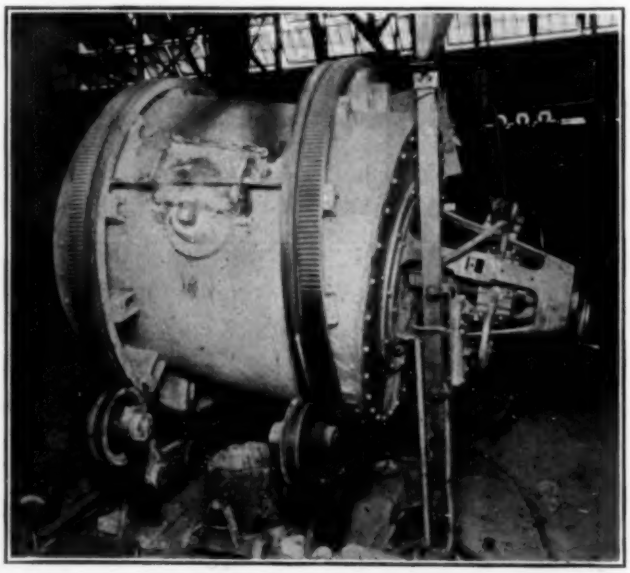


FIG. 2. ANOTHER VIEW OF THE REVOLVING ELECTRIC BRASS FURNACE

The furnace must be started with a charge of previously melted metal, and sufficient metal to fill the loop must be retained when pouring. The metal in the loop must never be allowed to solidify, or the lining will be ruined. These facts make it difficult to change from one alloy to another, and require that the furnace be run 24 hours a day, or else receive enough power at night to keep the metal in the loop fluid. Ramming up and drying the refractory lining of the loop is a job requiring care and experience, as the lining must be perfect or its life will be short. No lining has yet been found that will withstand alloys containing over 3 per cent of lead, and the furnace has been developed mainly for yellow brass.

The furnace is fitted for rolling mill use, where 24-hour operation on yellow brass is the rule, but is distinctly less suitable for 10-hour runs or for foundries making a variety of alloys.

Several of these furnaces are in use at the Ajax Metal Company, Philadelphia, two at the American Brass Company, Waterbury, Conn., and twenty-eight at the Bridgeport Brass Co., Bridgeport, Conn. The furnace saves zinc, avoids crucibles, and shows so low a power consumption on 24-hour operation that it can doubtless be used to advantage in rolling mill practice even under normal prices of fuel and crucibles.

Furnaces Under Experimental Test

Besides the four types mentioned above, each of which has found commercial use where conditions were suitable, there are four other furnaces that have reached a semi-commercial stage, but are still under experimental development.

The Bennett furnace at the Scovill Mfg. Co., Waterbury, Conn., is a three-phase furnace, probably of about 750-lb. capacity, and resembles a direct-arc furnace. However, the voltage between electrodes (which are automatically regulated) and bath is kept so low that there is no true arc and the heat is generated by a sort of contact resistance. This is said to give low metal losses and to show a reasonably low consumption of power.

The furnace has run mainly on yellow brass and is therefore probably applicable to all brasses and bronzes. The results of the work have so far been kept secret and no detailed data are available.

The Foley furnace is a single-phase, vertical-ring induction furnace, similar in general design to the Ajax-Wyatt, although differing from it in many points. One such furnace of about 1000-lb. capacity has been in experimental operation at the Bristol Brass Company, Bristol, Conn., and three 3000-lb. furnaces are under construction. From the few data so far available on this furnace, its metal losses and power consumption will be about the same as in the Ajax-Wyatt; partly because of larger size its power factor is somewhat lower. It has the same disadvantages as regards starting, changing from one alloy to another, and the necessity for 24-hour operation, as that furnace.

The General Electric furnace is a smothered-arc, one or two-phase furnace, normally two of about 1500-lb. capacity, having four depending electrodes, two on each side of a hearth. Between the tips of each pair of electrodes is a carbon block to which arcs are drawn, the arcs being smothered by granular coke. The heat thus generated is reflected down onto the hearth by the roof. The electrodes are automatically regulated.

After being tested at the General Electric Company, Schenectady, N. Y., this furnace has been installed for further test at the Chicago plant of the Crane Company, but is not yet considered ready for general commercial use.

The heat transfer in this type is similar to that in the Baily, and the furnace seems theoretically capable of a performance of about the same order as the Baily with similar advantages and similar drawbacks. As the General Electric furnace takes a higher power input than the Baily, it may be slightly more efficient in power consumption, but the roof is subject to even more severe conditions and will require the use of high grade refractories to give a good life.

The Northrup furnace, being developed by Prof. E. F. Northrup and the Ajax Metal Company, is an induction furnace, heating the charge by means of eddy currents instead of making the charge, or part of it, the secondary of a transformer. Oscillating current of very high frequency is used instead of alternating current, and is obtained by the use of condensers or a special generator. A 60-kw. tapping-type furnace is being tried out. The Northrup furnace has a high power factor, and can take multiphase current. It is being developed in order to produce a furnace suitable for 10-hour operation and for facility in changing from one alloy to another.

Since the heat is generated within the charge itself, the eddy current furnace should be efficient in power consumption. This type is theoretically very promising, but its development has not yet gone far enough to show what, if any, mechanical limitations the type will have.

Many other types of furnaces have been suggested for brass melting, and a number have been tried out more or less thoroughly, but those mentioned above are the most prominent of the types in commercial use or under commercial development. Most of these are either limited in their application, or have some drawbacks, either inherent in the type of furnace, or not yet eliminated by long experience in their design and use, so that no one type or make of furnace is as yet definitely proved the best for any particular set of conditions, and still less will any one furnace meet all the different conditions found in the whole range of the brass and bronze industry.

In particular, none of these types seems quite fitted to that common set of conditions where a furnace may be called upon to melt successive heats of alloys differing widely in composition, to handle both alloys free from zinc and those high in zinc, and to operate cheaply on a 9 or 10-hour day.

Rocking Electric Brass Furnace

In its study of electric brass melting during the past five years, the Bureau of Mines has tried out a rocking-type of furnace, which may perhaps help to fill this gap.

In the ordinary indirect-arc type of furnace, the heat is applied above the melt and as hot metal is lighter than colder metal, there is little circulation in the bath. If the rate of heat input is at all rapid, as is necessary for thermal efficiency, heat conduction from the top of the melt downward does not keep pace with the heat supply. Before the melt as a whole reaches the proper pouring temperature, the surface is much superheated.

On an alloy high in zinc the surface will reach the boiling point of the zinc in that particular alloy while the bottom is scarcely melted. Such heating creates a high pressure of zinc vapor within the furnace so that if it is not tightly closed zinc is lost continually. If the furnace is sealed tight, the pressure may even blow out the roof or door. In case the furnace holds tight and the pressure is not relieved till the spout is opened for pouring a long hissing stream of zinc vapor then shoots out, burning in the air. This local overheating is the cause of the failure of the indirect-arc furnace to handle alloys high in zinc without large metal losses.

The obvious way to overcome this trouble is to stir the melt so vigorously that the temperature of the melt is practically uniform and the superheating of the surface prevented. The most practical way to stir the melt is by the principle of the cement-mixer, by turning the furnace bodily so as to stir the contents thoroughly while being heated. Constant rotation of a cylindrical furnace placed more or less horizontally, but preferably at a slight angle with the horizontal to produce endwise motion of the melt during rotation, with electrodes entering at the ends of the drum and an arc struck between the electrodes should not only stir the charge thoroughly, avoid surface over-heating and thus pre-

vent zinc losses, but should also give a well-mixed alloy. By washing the walls with metal the heat stored in the walls and roof should be largely taken up in the metal instead of passing out. The power consumption should therefore be low. As the walls are washed with metal their temperature can rise but little above the temperature of the metal, which should give a good life of lining.

Instead of rotating the furnace through a complete revolution which would involve difficulty in keeping the metal out of the joints between the door and the door opening, as this opening should be on the circumference of the drum rather than on the end—and in making brush contacts to the electrodes, it appears simpler to rock the furnace back and forth so that the molten charge just fails to reach the door at either end of its rocking angle.

Results of Laboratory Tests

A small furnace of this type was built and tried out. This was rocked back and forth by hand on tracks. It was cheaply constructed from materials at hand in the laboratory and was not expected to give very good results on power consumption, as the drum was too small to allow the refractory lining to be of desirable thickness.

The laboratory furnace held about 100 lb. of charge, and operated on 50 to 75 volts and 500 to 700 amperes at a power factor of 85 to 90. The usual power input was about 30 kw. Graphite electrodes 2 in. in diameter were used.

A number of different alloys were melted in the rocking furnace. In melting 1092.1 lb. of yellow brass, made up of 45 per cent ingot, 55 per cent copper and zinc, the calculated analysis being 65.6 per cent Cu, 34.4 per cent Zn, 1080.4 lb. of ingot was obtained, analyzing 65.9 per cent copper, 34.1 per cent zinc. The metal loss by weight was 1.06 per cent which includes both volatilization and mechanical loss by spatter in pouring. The average pouring temperature was 1080 deg. C.

On manganese-bronze chips (40 per cent zinc) the furnace gave a net metal loss of 3.0 per cent while the same lot of chips melted in oil-fired crucible furnaces in commercial practice gave 7.2 per cent loss.

Yellow brass chips (25 per cent zinc) gave 1.6 per cent net loss, red brass chips (10 per cent zinc) 1.0 per cent.

A fine concentrate (20-mesh) from brass-furnace ashes, obtained in the manufacture of an alloy of 80 per cent copper and 20 per cent zinc, analyzed 71.0 per cent copper and 14.3 per cent zinc, the balance being ash, etc. After melting in the furnace 99 per cent of the copper and 50 per cent of the zinc in the concentrate were recovered. This material is usually sent to the smelter and refined in a reverberatory furnace, not all of the copper and none of the zinc being recovered.

Yellow brass ingot (25 per cent zinc) was remelted with 0.5 per cent loss. Red brass (10 per cent zinc), made from red gates, scrap copper, yellow chips, lead and tin, was melted with 0.5 per cent loss.

Heavy German silver scrap (18 per cent nickel, 56 per cent copper, 26 per cent zinc) which gave 1.8 per cent loss on commercial melting in coke fires was melted with 1.2 per cent loss.

Sound copper castings were made from metal melted in the furnace.

Red brass of 81½ per cent copper, 8½ per cent zinc, 6 per cent lead, 4 per cent tin, made from red and yellow ingot and scrap copper, was melted in one series of tests with the following results, the furnace being cold at the start.

TABLE I.

Heat No.	Weight of Charge, Lb.	Time Arc Was On. Minutes	Pouring Temp., °C.	Kw.-Hr. Used	Kw.-Hr. per 100 Lb.
L 34	127.3	57	1,140	40	30½
L 35	127.75	50	1,180	30½	25
L 36	128.5	50	1,220	26½	20½
L 37	126.5	37	1,220	22½	17¾
L 38	129.5	36	1,220	19	14¾
Total	639.55	Av. 46	Av. 1,200	Total 138½	Av. 21¾

The total elapsed time for the five heats, including charging and pouring, was 5 hours; 630.9 lb. ingot poured and 7.45 lb. metal from spillings, etc., recovered, giving a gross metal loss of 1.35 per cent and a net loss of 0.2 per cent.

The power consumption, at the rate of 430 kw.-hr. per ton on a five-hour run, starting from the cold, and at the rate of 295 kw.-hr. per ton when the furnace is hot, with the metal heated to 1200 deg. C, is surprisingly low for so small a furnace.

The results above show that the rocking furnace is a type capable of giving low metal loss and low power consumption. When the furnace was not rocked while melting alloys high in zinc, pressure built up within the furnace and zinc losses were high.

Description of Commercial Furnace

The laboratory tests having demonstrated the probable usefulness of the type, a furnace of commercial size was designed.

The Detroit Edison Company had long been interested in electric brass furnaces as a possible outlet for electric power, and offered to co-operate by constructing a rocking furnace for commercial test without expense to the Bureau of Mines except for the salaries and expenses of its representatives while supervising the test.

Sketches of the furnace design were given the Detroit Edison Company, which refined the design, made the working drawings, constructed and erected the furnace. Two views of the furnace are shown in accompanying illustrations.

The drum is 5 feet in diameter by 5 feet long. The lining is 12 in. thick, and consists of Sil-o-cel brick on the outside, special heat-insulating brick in the middle layer and corundite brick (a very refractory firebrick high in Al_2O_3) in the actual hearth lining. The hearth is 3 feet long by 3 feet in diameter, taking charges of 1300 lb. and upwards. The electrodes are 4 in. diameter graphite, threaded for continuous feed, and are adjusted by screw-operated supports of the lathe-slide type. Single-phase, 60-cycle current, stepped down to 120 to 130 volts is used, 30 kva. being available. Electrode adjustment is by hand, and, to stabilize the arc an external reactance is used which brings the power factor of furnace plus reactance, measured at the furnace switchboard, to about 85. The open circuit voltage falls to about 106 to 116 volts under load. The current varies between 1000 and 2000 amperes, 1650 amperes being about the average. The power input can be varied by altering the length of the arc, and runs from 100 to 200 kw. averaging about 165 kw.

The flexible leads and the water hose for electrode cooling are given slack to allow rocking the furnace, as is clearly shown in Fig. 1.

The rocking of the furnace during melting is done automatically by means of a control device which can be set to give a "safe rock" of 80°, the limit of motion being such that the metal just does not run into the spout. After the charge has begun to melt, the "safe rock" is started. It is called the "safe" rock because the angle is such that solid charge will not fall on the electrodes and break them. A complete oscillation on safe rock takes 13½ seconds.

During the safe rock the solid metal is swashed about in the molten part of the charge and is tumbled over, so that fresh surfaces receive direct radiation from the arc. As melting goes on, the rocking angle is increased by turning the handle of the control device from time to time, until, when the metal is all melted, the furnace is on the "full rock" of about 200°. On full rock the metal washes the whole circumference of the hearth save the height of the charging door and a few inches above and below it, so that metal does not splash into the door joint. A complete oscillation takes 33½ seconds.

The reversal of the 5-hp. motor at either end of the rocking angle is done by contactors, operated by solenoids actuated by the contacts on the control device.

When it is desired to depress the spout past the limiting point of the automatic rock, for pouring, the control device is switched out and the solenoids are operated by a reversing switch.

Comparison with Coke-fired Furnaces

The furnace is installed at the plant of the Michigan Smelting and Refining Company, Detroit, Michigan, which makes brass ingot to customers' specifications from chips, scrap and junk of various kinds, by means of strict chemical control. As the firm makes no sand castings, but ingot only, no observations were possible on the comparative quality of metal melted in the electric furnace and in the coke fires. All the metal melted was poured into ingot which went into the regular output of the plant. As far as could be told by analysis and appearance, the electrically melted metal was of at least as good a quality as that from the coke fires. On alloys high in lead there was somewhat less segregation than in the metal melted in crucibles, and on charges high in zinc, the zinc content of the metal from the electric furnace was higher than that from the same charges melted in the coke fires.

As there is generally much oil on the borings and some non-metallic material in the other scrap, the true metallic content of the charge is seldom accurately known. Hence the net metal losses cannot be exactly determined.

The metal losses were therefore compared with those of the coke-fired crucible furnaces operating on the same charge.

From 102 tons of metal melted in strict comparison with the crucible furnaces, the rocking electric furnace produced 3626 lb., or 1.8 per cent more metal from the same charge than did the coke fires. The alloys melted ran from 90 per cent to 66 per cent copper, 1 per cent to 9 per cent tin, 1½ per cent to 26½ per cent lead, 0 to 30 per cent zinc.

The comparative metal losses on a few alloys in the electric and the coke fires are given in Table II.

TABLE II.

Composition Per Cent Cu	Sn	Pb	Zn	Weight Charged, Lb.	Per Cent Loss (Metal, Oil and Dirt) Coke Fires	Per Cent Loss (Metal, Oil and Dirt) Electric Furnace
85	5	5	5	6,576	4.6	3.2
84	7	8	1	11,600	7.0	3.7
84	6	10	0	14,300	2.4	1.8
79	9	10	2	11,790	3.6	2.1
78	2	10	10	15,840	7.1	3.1
76	8	13	3	11,805	4.0	2.4
73	4	20	3	14,392	3.7	2.9
67½	4	26½	2	5,224	3.0	2.4
67	1	2	30	7,200	8.0	5.1

TABLE III.

Per Cent	Copper	Tin	Lead	Zinc
Sought	76.0	8.0	13.0	3.0
Electric	75.9	8.3	13.1	2.7
Sought	76.0	8.0	13.0	3.0
Electric	76.2	8.0	12.4	3.2
Sought	85.0	5.0	5.0	5.0
Electric	85.2	4.9	4.8	5.0
Sought	83.0	4.0	6.0	7.0
Electric	82.9	4.4	5.7	6.9
Sought	67.0	1.0	2.0	30.0
Electric	66.6	1.0	2.0	30.4
Coke	68.4	0.5	1.7	29.3
Sought	68.0	1.0	7.0	24.0
Electric	67.9	...	....	....
Coke	69.9	...	....	....

The rocking furnace gave alloys that analyzed very close to the calculated analysis, especially if the difficulty of calculating the analysis of a scrap charge is considered. Characteristic analyses are given in Table III.

There was no difficulty in draining the metal completely from the hearth, and alloys of different composition could be made one after the other without contamination by metal remaining from the previous heat.

The power consumption on 10-hour operation, with no night heating is shown in Table IV, which gives a résumé of 5 days operation.

The power consumption on 24-hour operation is shown in Table V, for a 4-day run.

In the 24-hour tests tabulated in Table V and in a 10-hour run just preceding, in which the 75¼ Cu, 7½ Sn, 14¼ Pb. 3 Zn alloy was melted, the charge was as follows:

Ingot	25,200 lb.	
Red borings	11,200 lb.	2% oil = 224 lb. non-metallic
Medium brass	1,540 lb.	
Scrap Cu	10,987 lb.	
Ingot Cu	552 lb.	
Ingot Pb	3,906 lb.	
Yellow borings	1,400 lb.	3% oil = 42 lb. non-metallic
	54,805	266

For the 86 Cu, 6 Sn, 10 Pb alloy there was charged:

Ingot	16,000 lb.
Cu	4,704 lb.
Pb	96 lb.
	20,800 lb.
Total charge	75,605 lb.
	266 lb. non-metallic
	75,339 lb. metallic

There was obtained:

53,841 lb. good ingot 75¼ Cu
20,149 lb. good ingot 86 Cu

73,990 lb. total good ingot, 1,349 lb. gross loss, or 1.8 per cent.
63 lb. scrap 75¼ Cu
43 lb. scrap 86 Cu
300 lb. metallics in 569 lb. skimmings from 75¼ Cu } 53 per cent. metallic in
130 lb. metallics in 246 lb. skimmings from 86 Cu } all skimmings by assay

365 lb. metallics in 429 lb. ladle skulls from 86 Cu 85 per cent. metallic

74,891 total metallic recovery—448 lb. net loss, or 0.6 per cent.

On the basis of power read on the high-tension side of the transformer, per ton of metal poured, 336 kw.-hr. per ton, on red brass poured at 1180 deg. C. average temperature. For 24-hr. operation the figure is about 260 kw.-hr. per ton for red brass.

The electrode consumption was 16.3 lb. while melting 21660 lb. of metal, or 1½ lb. per ton, equivalent to about

40 cents at present electrode prices. To this must be added the loss due to accidental breakage. There were nine breakages in melting 72 tons, four of which were due to the charge being so bulky that it fell against the electrodes when rocking started, and five to the electrodes being hit, while bulky material was being charged. The design of the furnace has now been altered so as to allow the electrode tips to be withdrawn into the walls during the charging of bulky material. When an electrode does break, if nipple joints are used, the breakage is usually of the nipple only.

Since the operation was experimental, it is not yet possible to give exact figures on the life of a lining, but as near as can be estimated the relining cost for labor and material should be well under 50 cents per ton with a corundite lining when melting red brass poured at 1150-1200 deg. C. If only yellow brass, poured at 1100 deg. C. is melted, the lining cost will be still lower. If very hot bronze is to be produced, say at 1300 deg. C., the roof and upper portions of the ends should be lined with zirkite brick.

Advantages of Rocking Furnace

Accurate temperature control is very easy in the rocking furnace, since at the end of a heat, after the "full rock," the walls are no hotter than the metal, and there is no heating up of the charge from hotter roof and walls when the power is shut off, as is the case with those types of furnace where the heat is reflected downward from the roof. After cutting off the arc, the temperature falls very slowly, about 2 or 3 deg. C. per minute. By running the arc a minute or so every 10 or 15 minutes, a charge can be held at pouring temperature for an indefinite period.

One man can operate the furnace, with the aid of a helper while charging. Were automatic electrode con-

TABLE IV

Date	Heat No.	Cu	Alloys Sn	Pb	Zn	Nature of Charge	Pounds Charge	Elapsed Time	Sec. Kw.-Hr. Arc	Kw.-Hr. Motor	Total Sec. Power	Pouring Temp.	Weight Poured	Primary Kw.-Hr.	Secondary Kw.-Hr. Cwt. Charged	Primary Kw.-Hr., Cwt. Poured	Remarks
Nov. 5	192	85	5	9	1	Average	1314	3:40	257	4	261	2000°F. 1095°C.	.....	.....	20.0	....	Furnace cooler than usual, not run previous two days. No. 192 includes 1 hr. 20 min., 100 kw.-hr. preheat
	193	85	5	9	1	Average	1314	1:50	219	3	222	2050°F. 1120°C.	.....	.....	17.0	....	
	194	79	9	10	2	Little bulkier than average	1304	1:35	196	2	198	2125°F. 1165°C.	.....	.....	15.0	....	
	195	79	9	10	2		1304	1:30	190	2	192	2200°F. 1205°C.	.....	.....	14.5	....	
	196	79	9	10	2	....	1304	1:40	190	3	193	2200°F. 1205°C.	.....	.....	15.0	....	Time includes 20 min. charging heat 197
Day total, 5 heats							6540	10:15	1052	14	1066	2115°F. 1155°C.	6360	1162	16.3	18.3	
Nov. 6	197	79	9	10	2	Little bulkier t an average	1304	1:45	235	3	238	2125°F. 1165°C.	.....	.....	18.3	....	
	198	79	9	10	2		1304	1:30	199	3	202	2175°F. 1190°C.	.....	.....	15.5	....	
	199	79	9	10	2		1304	1:40	186	2	188	2250°F. 1230°C.	.....	.....	14.5	....	
	200	79	9	10	2		1304	1:40	176	2	178	2240°F. 1225°C.	.....	.....	13.5	....	
	201	79	9	10	2		1304	1:30	162	2	164	2100°F. 1150°C.	.....	.....	12.5	....	
	202	79	9	10	2		1304	1:45	160	2	162	2125°F. 1165°C.	.....	.....	12.5	....	Time includes 20 min. charging heat 203
Day total, 6 heats							7824	9:50	1118	14	1132	2185°F. 1195°C.	7571	1236	14.7	16.3	
Nov. 7	203	79	9	10	2	Little bulkier t an average	1304	1:35	215	3	218	2125°F. 1165°C.	.....	.....	17.0	....	
	204	79	9	10	2		1304	1:40	195	2	197	2165°F. 1185°C.	.....	.....	15.0	....	
	205	79	9	10	2	....	1304	1:30	180	2	182	2175°F. 1190°C.	.....	.....	14.0	....	
	206	79	9	10	2	....	1304	1:35	173	2	175	2140°F. 1170°C.	.....	.....	13.5	....	
	207	84	6	10	0	Very bulky	1304	1:40	165	2	167	2150°F. 1175°C.	.....	.....	13.0	....	
	208	87½	5	½	7		1304	2:30	178	3	181	1950°F. 1065°C.	.....	.....	14.0	....	Includes 50 minutes delay by broken electrode broken in charging bulky charge, also 20 minutes charging heat 209
Day total, 6 heats							7824	10:30	1106	14	1120	2120°F. 1160°C.	7583	1210	14.4	16.0	
Nov. 8	209	84	6	10	0	Very bulky	1300	3:00	246	2	248	2050°F. 1120°C.	.....	.....	19.0	....	Time includes 1 hr., 10 min. delay due to broken electrode due to bulky charge. Long delay due to nipple being over-size and requiring to be filed down
	210	84	6	10	0		1300	1:40	198	3	201	2175°F. 1190°C.	.....	.....	15.5	....	
	211	84	6	10	0		1300	2:05	188	2	190	2175°F. 1190°C.	.....	.....	14.5	....	Includes 25 min. adjusting electrode holder
	212	84	6	10	0		1300	1:30	169	3	172	2175°F. 1190°C.	.....	.....	13.5	....	
	213	84	6	10	0		1300	1:50	170	1	171	2175°F. 1190°C.	.....	.....	13.0	....	Includes 20 min. charging No. 214
Day total, 5 heats							6500	10:05	971	11	982	2150°F. 1175°C.	6341	1069	15.1	16.9	
Nov. 9	214	84	6	10	0	Very bulky	1300	1:45	223	4	227	2175°F. 1190°C.	.....	.....	17.5	....	
	215	84	6	10	0		1300	2:05	198	3	201	2200°F. 1205°C.	.....	.....	15.5	....	
	216	84	6	10	0		1300	1:00	195	2	197	2160°F. 1180°C.	.....	.....	15.0	....	
	217	84	6	10	0		1300	1:45	189	3	192	2250°F. 1235°C.	.....	.....	14.5	....	
	218	84	6	10	0		1300	1:25	165	2	167	2150°F. 1175°C.	.....	.....	13.0	....	
Day total, 5 heats							6500	8:50	970	14	984	2190°F. 1200°C.	6407	1073	15.2	16.7	

trol used, which could easily be done, one man could probably attend to two furnaces.

The output per man-hour was greater from the rocking furnace than from the coke fires. The working conditions are much less severe and more healthful with the electric furnace than with the coke fires, and a man of less rugged physique than is required for coke fires can readily operate the rocking furnace.

Various modifications and improvements in design were made during the tests, and others that could not well be made on the first furnace are being incorporated in other furnaces of this type now being built for Detroit firms. The electrodes were at first introduced into the furnace directly through the refractory walls. When making yellow brass from new materials so that addition of much spelter is required, the zinc, vaporized during the addition of the spelter to the molten charge, tended to condense in the clearance between the electrode and the hole through which it entered. This would then freeze, solder the electrode in place and cause breakage. Such trouble was later obviated by the use of graphite sleeves about the electrodes and by the proper arrangement and operation of the electrode coolers. It was also found feasible to charge the zinc with the rest of the charge instead of speltering at the end of the heat.

Comparative Costs and Power Consumption

Comparing the cost of melting on a 10-hour schedule in the rocking electric furnace and in the coke fires of

TABLE V. POWER CONSUMPTION ON 24-HR. OPERATION

Date	Conseq. Heat No.	Day Heat No.	Weight of Charge Lb.	Alloy Per Cent Cu	Sn	Pb	Zn	Elapsed Time Hr.	Min.	Melting Time Hr.	Min.	Kw.-Hr. Arc Plus Rocking Motor Read on Secondary Side	Equiv. Kw.-Hr. on Primary Side	Pri. Kw.-Hr. per Ton Charged	Remarks
Apr. 30	261	1	1,305	75¼	7¼	14½	3	2	9	1	47	229	....	....	Started at 6:30 a.m. Furnace idle since 4:30 p.m., Apr. 29
	262	2	1,305	75¼	7¼	14½	3	1	53	1	28	192	....	....	
	263	3	1,305	75¼	7¼	14½	3	1	55	1	22	168	....	....	
	264	4	1,305	75¼	7¼	14½	3	1	44	1	15	152	....	....	
	265	5	1,305	75¼	7¼	14½	3	1	44	1	15	144	....	....	
	266	6	1,305	75¼	7¼	14½	3	2	12	1	2	141	....	....	30 min. (included in elapsed time), adding electrode sections and taking new grips
	267	7	1,305	75¼	7¼	14½	3	1	30	..	55	153	....	....	
	268	8	1,305	75¼	7¼	14½	3	1	35	..	58	156	....	....	
	269	9	1,305	75¼	7¼	14½	3	1	41	1	..	151	....	....	
Midnight	270	10	1,305	75¼	7¼	14½	3	1	33	1	2	146	....	....	
	271	11	1,305	75¼	7¼	14½	3	1	33	..	59	143	....	....	
	272	12	1,305	75¼	7¼	14½	3	1	47	1	6	149	....	....	
	273	13	1,305	75¼	7¼	14½	3	2	1	1	2	150	....	....	18 min. (included), replacing broken electrode nipple; heat ended 5.40 a.m.
Day total,			16,965					23	17	15	11	2,074	2,270	268	
May 1	274	1	1,305	75¼	7¼	14½	3	2	11	1	18	143	....	....	36 min. (included) wait for helpers to pour metal
	275	2	1,305	75¼	7¼	14½	3	1	49	1	12	147	....	....	
	276	3	1,305	75¼	7¼	14½	3	1	40	1	7	152	....	....	
	277	4	1,305	75¼	7¼	14½	3	1	35	..	55	147	....	....	
	278	5	1,305	75¼	7¼	14½	3	1	45	1	12	142	....	....	
	279	6	1,305	75¼	7¼	14½	3	3	..	1	20	160	....	....	1 hr. 10 min. (included), replacing broken electrode and altering cooling coil
	280	7	1,305	75¼	7¼	14½	3	1	32	1	2	151	....	....	
	281	8	1,305	75¼	7¼	14½	3	1	21	..	57	146	....	....	
	282	9	1,305	75¼	7¼	14½	3	1	19	..	53	145	....	....	
	283	10	1,305	75¼	7¼	14½	3	1	23	..	55	151	....	....	
Midnight	284	11	1,305	75¼	7¼	14½	3	1	31	..	56	152	....	....	
	285	12	1,305	75¼	7¼	14½	3	1	34	1	1	152	....	....	
	286	13	1,305	75¼	7¼	14½	3	1	20	..	48	141	....	....	
	287	14	1,305	75¼	7¼	14½	3	1	35	..	53	147	....	....	
Day total,			18,270					23	35	14	27	2,076	2,272	249	End of heat at 5:20 a.m.
May 2	288	1	1,305	75¼	7¼	14½	3	1	35	1	5	150	....	....	Heat started at 6:35 a.m. Furnace idle 1 hr. 25 min. between shifts
	289	2	1,305	75¼	7¼	14½	3	1	25	..	52	145	....	....	
	290	3	1,305	75¼	7¼	14½	3	1	25	..	57	143	....	....	
	291	4	1,305	75¼	7¼	14½	3	1	[illegible]	..	53	141	....	....	
	292	5	1,305	75¼	7¼	14½	3	1	35	1	2	144	....	....	
	293	6	1,305	75¼	7¼	14½	3	1	39	..	56	141	....	....	Much delay in pouring this heat—no helpers
	294	7	1,300	84	6	10	0	1	31	1	04	140	....	....	
	295	8	1,300	84	6	10	0	1	18	..	50	150	....	....	Furnace idle 45 min. at change of shifts, between 294 and 295
	296	9	1,300	84	6	10	0	1	48	..	59	158	....	....	
	297	10	1,300	84	6	10	0	1	22	..	52	151	....	....	
	298	11	1,300	84	6	10	0	2	13	1	5	156	....	....	39 min. (included), replacing broken electrode
Midnight	299	12	1,300	84	6	10	0	1	28	..	59	162	....	....	
	300	13	1,300	84	6	10	0	1	37	1	10	179	....	....	
	301	14	1,300	84	6	10	0	1	49	1	12	163	....	....	Heat ends 5:20 a.m.
Day total,			18,230					22	05	13	59	2,126	2,318	254	
May 3	302	1	1,300	84	6	10	0	1	43	1	14	167	....	....	Heat started 6:45, furnace idle 1 hr., 35 min. between shifts
	303	2	1,300	84	6	10	0	1	43	1	22	158	....	....	Furnace idle 1 hr. between 302 and 303; operator in conference
	304	3	1,300	84	6	10	0	1	55	1	9	158	....	....	Furnace idle 1½ hr. between 303 and 304. Broke electrode charging 304; none on hand, wait for one from machine shop
	305	4	1,300	84	6	10	0	1	44	1	17	159	....	....	
	306	5	1,300	84	6	10	0	1	50	1	16	166	....	....	25 min. patching electrode hole between 304 and 305
	307	6	1,300	84	6	10	0	1	35	1	10	162	....	....	
	308	7	1,300	84	6	10	0	1	23	1	10	162	....	....	
Midnight	309	8	1,300	84	6	10	0	2	15	1	5	165	....	....	42 min. (included) delay. Broke 2 electrode nipples charging
	310	9	1,305	75¼	7¼	14½	3	1	19	..	55	152	....	....	
	311	10	1,305	75¼	7¼	14½	3	1	14	1	..	140	....	....	
	312	11	1,305	75¼	7¼	14½	3	1	21	..	50	142	....	....	
	313	12	1,305	75¼	7¼	14½	3	1	36	1	13	144	....	....	Last ladle poured 6:35 a.m.
Day total,			15,620					19	38	13	41	1,875	2,005	262	
4-day total,			69,085	...	..	...	..	..	..	..	..	....	8,865	257	

the plant at which the test was made, the sum of the cost per ton of charge for electric power, interest and depreciation, electrodes, linings, and for heating ladles, is just about one-half of the cost per ton of charge of the single item of crucibles at present prices and at present crucible life. The value of the metal saved by the electric furnace is about twice the cost of the coke used by the coke fires. Hence a huge saving is possible by electric melting under present conditions; and even at pre-war prices for crucibles, coke and metals, the rocking furnace will show a smaller, but still a distinct, saving. On 24-hour operation the balance in favor of electric melting is still more marked.

From data on hand on the power consumption of other types of electric furnaces, it appears that, when operated on the same alloy, heating it to the same temperature, and running the same number of hours per day, the rocking furnace is somewhat more efficient than the direct-arc and un-rocked indirect-arc types, very much more efficient than electric furnaces of types in which heat is reflected onto the charge from the roof, and very little less so than the induction furnaces. These conclusions follow not only from the data at hand, but from the method of application of heat in the various types, those with the source of heat at a distance from the charge being less efficient than those where the heat is developed close to the charge; the induction furnaces in which the heat is developed in the charge itself should be the most efficient. On account of the washing of the walls with the metal, the rocking furnace should theoretically come next to the induction type in thermal efficiency.

Comparative Metal Losses

In magnitude of metal losses, the rocking furnace gives at least as good results as any other type of electric furnace. The only possible loss is from the stream of metal while pouring, as the furnace is sealed tight while running. Volatilization from the stream while pouring is of course about the same in all types of furnaces.

In closeness of control of the temperature of the melt the rocking furnace is superior to any save the induction type. In thorough mixing of the charge, the rocking type is about on the same plane as the induction type, and markedly superior to the other types, where, in large sizes, segregation in the bath may be a serious problem. For example, the following shows the analysis for copper of the first ingot from the first ladle and of the last ingot from the last ladle when melting 1200-lb. charges of 60 per cent Cu, 37 per cent Zn, 3 per cent Pb.

Heat	First Ingot, First Ladle	Last Ingot, Last Ladle
322	59.76% Cu	59.54% Cu
323	59.78% Cu	59.66% Cu

In ability to change from one alloy to another, it is superior to the vertical-ring induction type; and in ability to operate cheaply when used but 10 hours a day, without night heating, it is ahead of the vertical-ring induction type and of the reflected-heat types.

The rocking furnace can handle alloys of any zinc or lead content, being superior on this score to direct-arc, unrocked indirect-arc and induction types. The electrode cost compares favorably with other arc furnaces. With equal conditions of operation, and suitable refractories in each type, the cost of lining will probably be about the same as with most other types. Labor cost should be about the same in all hand-regulated arc furnaces. With automatic regulation, which can be applied if desired, the rocking type should show a labor cost about the same as that of any other type.

Load With Rocking Furnace Not So Steady As With Induction Type

From the electrical point of view, of desirability of a steady load, the rocking furnace does not have so steady a load, and hence, on this score, is not so desirable as the induction furnaces or granular resistor furnaces. It does not require special transformers, as the granular resistor type does. It lacks the electrical advantages of multiphase furnaces. In very large sizes, two arcs could be used in the rocking type, but in sizes up to one ton, single-phase operation is required, and in a plant so located that the power supply must be of limited capacity, a single-phase arc furnace, with its fluctuating loads, may not be satisfactory from the electrical point of view. Such fluctuation is no drawback in Detroit nor would it be in most cities or large manufacturing towns.

From the results on furnaces of 125 and 1300 lb. capacity, it appears that the rocking type can be built in a wide range of sizes without showing a great loss of efficiency in the smaller sizes. This type can doubtless be built in as large sizes as the brass industry could normally use.

In first cost, the rocking type should be no more expensive than other electric furnaces.

While further tests in different plants and under different conditions, which will, at least in part, be made in the near future, are neded to give accurate data on the complete performance of the rocking type of furnace, it would seem from the results so far that it may be of distinct value in the brass industry, especially under present conditions as to crucible prices and quality, fuel supply and prices, and metal prices.

At the conclusion of the tests conducted by the Bureau of Mines, which covered over 300 heats, the experimental furnace was put on regular production by the Michigan Smelting & Refining Co. Four one-ton rocking furnaces are being built for this company and two for the Electro Bronze Co.

Licenses to Make Furnace Granted by Bureau of Mines

The patents taken out by the Bureau of Mines on the rocking furnace have been assigned to the Secretary of the Interior as trustee, and free licenses to operate under them can be obtained by making application through the Director of the Bureau of Mines.

Grateful acknowledgement is made to Cornell University for use of the well-equipped Cornell electric furnace laboratory in the work on the laboratory furnace; to Dr. J. M. Lohr, formerly of the Bureau of Mines, for aid in the work on the laboratory furnace; to the Michigan Smelting and Refining Company for facilities for the test, and to the Detroit Edison Company, and particularly to Mr. E. L. Crosby of the latter firm, for never-failing co-operation.

A more detailed account of the tests of the rocking furnace will soon be published as *Bulletin* 171 of the Bureau of Mines.

The Miles Acid Process for Sewage Disposal

Sewage Disposal Is a Problem in Chemical Engineering to Show How to Use Waste Materials. Tests of a New Chemical Process in Connecticut

SEWAGE disposal is really a municipal problem, and as such there is often the hazard that it may become either Republican or Democratic. When this occurs the best thing for the enquirer to do is to wander away somewhere else for his research, because when politics gets mixed up with it the pollution is likely to become too great even for sewage to endure.

Everybody knows that the situation, as it exists today in regard to municipalities in America is about as bad as it can be, this side of epidemics. In New York Harbor along the Brooklyn shore line there are places where the water is not changed by the tide, where it lacks oxygen and where, in sludge deposits on the bed of the river, a septic condition has arisen. This invites disease and we also know that disease will not refuse an invitation of that sort if there is perseverance in the bidding. Chicago needs more water from the Lake to carry its wastes down the drainage canal, and Uncle Sam seems to be of opinion that Lake Michigan hasn't any more water to spare to hasten Chicago sludge down the Mississippi River. New Haven, Conn., was cautioned by U. S. Government engineers that the harbor was becoming polluted with sewage, and that fishing for oysters must stop. Prof. C. E. A. Winslow of Yale University is now making comparative tests there, to which we shall refer at length later. Boston Harbor is receiving rather more than it can care for without offense to those that go down to the sea in ships and those that live along the shore.

The problem has become one for chemical engineers. The sanitary engineer has looked for and found places where sewage may be put until, so to speak, the places have become all filled up. So it is up to the chemist to find uses for sewage that are at once sanitary and economical, and thus to make it pay back some of the money it costs to get rid of it.

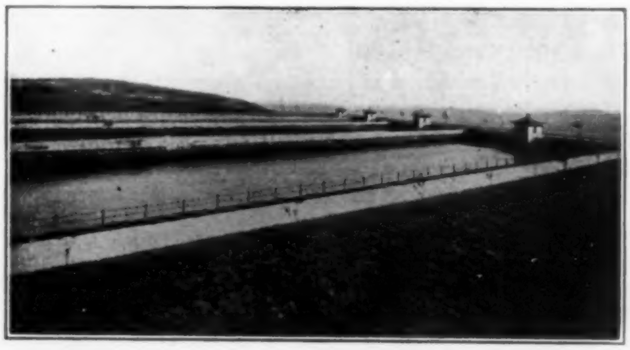
Activation seems to point out a way provided it may be carried far enough. The bacterial action seems to digest most of the polluting material and, under proper control, the effluent may be made crystal clear. The sludge, with fats reduced to 5 per cent or less is proved to be good fertilizer. The cost of installation is, unfortunately, pretty high.

Imhoff tanks get a great deal of the suspended matter from sewage and the effluent may be chlorinated and thus made reasonably safe. The sludge which is saved however, is both offensive and so far, nearly useless. It must be disposed of, and farmers do not seem to care for it.

Outline and Claim of the Miles Process

The acid treatment of sewage discovered and patented by George W. Miles, a Boston chemist, is very promising, and has been the subject of considerable discussion of late. In response to efforts made to establish a municipal sewage recovery plant in Boston a committee was appointed by the Massachusetts legislature to examine the merits of the proposal. In January of this year it made a report adverse to this and other known processes. The committee used bottles for their experiments, and their report is only worthy of interest because it shows the prejudice still to be found in the official mind. One of the special claims for the Miles process is the rapid sedimentation after acid treatment, 4 hours being held to be sufficient for this purpose in practice. The committee in their comparative tests in bottles allowed 18 hours for sedimentation and then drew their conclusions. Experiments of this sort shed darkness rather than light. Their main reason why it was recommended not to establish a recovery plant was because for many years in England, France and elsewhere, efforts to recover and use sewage have been unsuccessful! "Millions for Appropriations but Not One Cent for Research," might well be inscribed upon the City Hall of many an American municipality.

We offer the present record of the Miles process made up chiefly from statements of the inventor and his associates and from data which they have provided. We have also visited a 10,000-gallon test plant at New Haven, Conn., and we shall give a report of its operation at the conclusion. The subject is by far too important to neglect, inasmuch as, according to the claims



VIEWS OF FOUR SEDIMENTATION TANKS OF 12,500,000 GALLONS CAPACITY EACH IN BOSTON HARBOR PROVIDING AN OPPORTUNITY TO TEST THE MILES ACID PROCESS ON 100,000,000 GALLONS DAILY

of the inventor, an actual solution of the sewage problem is provided, while most of the studies made so far indicate a confirmation rather than a denial of his claims. The claims are in effect as follows: That by treating sewage with SO_2 or with nitre cake in the proper proportion, the soaps are broken up, 98 per cent of the grease is removed and recovered while the resultant sludge is not only inoffensive but an efficient low-grade nitrogen fertilizer; that the effluent is also clear and inoffensive and effectively sterilized; that plants may be established and operated without producing evil odors or unwholesome or unpleasant effects upon the immediate surroundings; that the materials recovered may be sold for enough to pay a fair return on the investment instead of being a tax upon municipalities; and that nothing escapes from the sewers into rivers, harbors or sinks but the sterilized effluent. Indeed, where irrigation is practicable, the effluent, which was found to contain 1000 lb. K_2O, 70 lb. P_2O_5, 120 lb. total organic nitrogen and 1.83 lb. nitrogen as ammonia per million gallons, may be run over limestone and used for irrigation. The excess acid in it was found to be only 30 parts per million.

Municipal sewage, as it emerges from the sewer, is fluid, cloudy and has a slight odor, although the process of fermentation is beginning. On evaporation it yields chiefly ammonia, glycerides, soap and nitrogenous materials. It contains also potash and phosphates, but the potash is mostly lost in the effluent in the Miles process.

Treatment with Sulphur Dioxide

The process provides that at the receiving tanks at the mouth of the sewer, a small portion of the sewage be pumped through an absorption tower with a counter current of SO_2. This SO_2-saturated sewage is run into the main sewer some distance back of its mouth so as to provide for thorough mixing. It flows at low velocity into a settling tank and by a continuous process into a second settling tank from which the effluent flows off. The size of the tanks must be such as to allow four hours for sedimentation in each series of two or more. During the four hours all but two per cent of the solids recoverable by settling are precipitated. The sludge collects at the bottom of the tanks but it is not removed daily. It is desired that it pack down, and to that end it is proposed to operate each series for several days to a week at a time before switching over to a duplicate series of collecting tanks. In tests made, no putrefaction occurs under these conditions. After the liquid is drawn from the settling tanks, the sludge which is pumped out contains 80 to 92 per cent of water, depending upon the method of treatment and the character of sewage.

From experiments made by Professor Robert Spurr Weston of the Massachusetts Institute of Technology on Boston sewage it was concluded that 1963 lb. of SO_2 is required to treat 1,000,000 gallons of sewage. That is roughly, a ton to the million gallons. That would require ½ short ton of sulphur or about one long ton of pyrites to produce the desired effect. Nitre cake may also be used for the purpose of breaking up the soaps, but in that event it is necessary to add a slight excess of SO_2 to stop and prevent fermentation. That is, it was determined by experiment that 3.82 tons of nitre cake was required with 200 lb. SO_2 to treat 1,000,000 gallons of sewage. The result is 1909 lb. of dried sludge, with 430 lb. of fats, according to Professor Weston. The Massachusetts Joint Commission in its adverse reports said that they had made "shorter" experiments which indicated 1427 lb. of dried sludge and 342 lb. fats per million gallons. Of course, neither the sludge nor grease is present in constant proportion but in tests made by Mr. E. S. Dorr of the Sewer Division of the City of Boston from June, 1911, to June, 1914, at frequent intervals there was found in Boston sewage an average of 1914 lb. sludge per million gallons, of which 22.33 per cent was grease by SO_2 precipitation.

The recovered sludge is like greasy, brown or grey mud. It has no odor and even after ten days in hot weather it lacks the offensiveness that it would have immediately acquired without treatment. It has rather a slight mouldy smell if kept too long before degreasing.

Sedimentation of Sludge in Series of Tanks

When the standing liquor has been drawn off and the sewage turned into one of the duplicate series of two or more settling tanks then in operation, the sludge is allowed to drain for a period, and then it is pumped up and, as the season favors, there may be partial air-drying. The final drying must be done under careful temperature regulation to prevent burning. The gases are not offensive and contain no NH_3.

The next process is the solvent extraction of grease from the sludge, which leaves a finely divided, practically grease-free fertilizer material containing 4½ per cent NH_3 and between 1 and 2 per cent P_2O_5. Whether this is economical is a problem in chemical engineering.

This freedom of the sludge from grease is important. It is claimed that sewage farming has generally failed because of the presence of soap and grease which clog the soil and make it "sick." When lime or copperas is used, as is frequently done, the sludge contains insoluble soaps and the value of the fertilizer is not developed. In this process it will be observed that the very first operation is to disinfect the sewage, remove the odor and break up all the soaps before the mouth of the sewer is reached, or as the sewage runs into the first settling tank. The chemical treatment, except the grease extraction, is completed in the very first step.

Commercial Value of Products

In 1913 the Amherst, Mass., Agricultural Experiment Station valued this dried, grease-free fertilizer at $15 to $16 per ton, and announced that over half the nitrogen content was in form to be valuable the first year. The value of nitrogen fertilizer has lately been quoted at $6.50 per unit of ammonia, which would make this which contains 4½ per cent NH_3, $29.25 per ton. It is either a low-grade fertilizer or a fertilizer base, to which tankage, phosphates and other ingredients may be added. Being in a very finely divided condition it should add humus to the soil. Tests for phosphoric acid showed from 1.2 to 1.6 per cent, while K_2O was present only to the extent of 0.03 to 0.14 per cent in the sludge.

The grease produced by extraction consists of glycerides and free fatty acids in the proportion of about half and half. It compares, according to the inventor, with garbage grease. It was worth about 4½ cents per pound at pre-war prices. Since then it has been quoted as high as 15 cents.

One million gallons of sewage at Moon Island, Boston Harbor, produce about 400 lb. of recoverable grease. This sewer, therefore, delivers to the tide, with its 100,000,000 gallons per day, 40,000 lb. of grease. That would indicate, assuming half the grease to be in the form of glycerides, a waste of one ton of glycerine besides 68 tons of fertilizer from this one sewer that now corrupts the harbor with the drainage of about 600,000 inhabitants.

Moisture and Fiber Are Obstacles

The great difficulty lies in the enormous quantity of water that must be evaporated and the fact that 15 to 40 per cent of the sludge is crude fiber. It balls up, and in a steam dryer it will cake and insulate the tubes. In this connection a patent has lately been granted to Mr. Walter H. Sawyer, of Lewiston, Me., who is interested in the company, for a screening device to remove the fiber, wash it with effluent, press down to 50 per cent water, degrease and, possibly, use as cheap paper stock. With the fiber removed the sludge may be reduced from 85 or 90 per cent to 67 per cent water, after which it is to be run through a thermal dryer. To get one ton of dry material from 85 per cent aqueous sludge, 11,000 lb. of water must be evaporated, whereas, when the water is reduced to 67 per cent only 4000 lb. needs to be evaporated; therefore the advantage of multiple effect evaporation, which is feasible down to 67 per cent moisture, may be obtained for 7000 lb. of the water for each ton of dry material. The figures are Mr. Sawyer's.

The effluent shows considerable variation in content. Comparative analyses show 1233 lb. K_2O from the North Metropolitan sewer in Boston Harbor and 888 lb. K_2O in that from Moon Island; 52 lb. P_2O_5 per million gallons also was found in the effluent. The acidity ranged from 1/15 to 1/100 of one per cent sulphurous acid. The bacterial count decreased from 4,000,000 per cc. in sewage to 400 per cc. in the effluent, and these were chiefly mould fungi. The New Haven experiments showed less favorable results in this respect, but it will be noted that the SO_2 supply was occasionally short owing to conditions that will be explained.

Estimated Costs and Profit

With the sewage adequately sterilized and deodorized at the beginning a proper installation should insure against pollution. The usual offensiveness would be done away with and such disposal plants might be put up in decent surroundings within the city limits and without danger of offense or disease contagion. The products recovered are of great economic promise and even in normal times should make the disposal of sewage cease to be the present financial and sanitary burdens that it is upon large municipalities. It provides for the metallurgical utilization of low-grade sulphurous ores, the SO_2 fumes from which may be liquified and shipped to the nearest towns. And it provides also for the use of all the niter cake that is produced. The estimated cost, based on present prices for large-scale plants, is $12,000 per million gallons to be treated daily. Mr. Weston computes the cost of acid treatment to be $7 to $9 per million gallons under pre-war conditions. The value of the grease under pre-war conditions he figures at $16 per million gallons and the fertilizer base as $10.20, or $26.20 for both. Under conditions as of Jan. 9 last, with grease at 15 cents per pound and ammonia in fertilizer at $6.20 per unit per ton, there should be $90.94 return per million gallons treated. That would provide under pre-war conditions $26.20 return per million gallons, less say, $9 for acid treatment, leaving $17.20 to defray cost of drying and degreasing the sludge recovered from a million gallons. Under present conditions with a cost of $20 for acid treatment and $90.94 received for grease and fertilizer, there would remain a margin of over $70 for the same purposes and for profit.

Comparative Test of Four Methods at New Haven

The foregoing figures are gathered chiefly from reports made by Professor Weston and Mr. E. S. Dorr of the Boston Department of Sewers. A late journey to New Haven and a conference with Professor C. E. A. Winslow in charge of the municipal experimental plant and Dr. F. W. Mohlman, his assistant, confirmed the above results in part. The problem at New Haven was not one of sewage recovery but rather the removal of 80 to 90 per cent of the settleable solids, the partial clarification of the effluent and disinfection as required. For this purpose tests of four methods were taken in comparative plants placed at the mouth of the East Street sewer which discharges about 13,500,000 gallons daily into the harbor, a total of more than half the sewage of the city of about 160,000 inhabitants. The tests are still in process and the final reports are not yet made, but thanks to Prof. Winslow and Dr. Mohlman we are permitted to give certain results which have been reached already.

The East Street sewer, 63 in. in diameter, carries the wastes of two great munition works, a part of that of a great hardware manufacturing concern and other important industries, and the experiment emphasizes the fact that sewage is a word with very miscellaneous meanings. The presence of considerable copper in solution from one of the munition works cuts down the bacteria count much below that usually found. A considerable amount of mineral oil is present. One factory pumps up large quantities of sea water for a condenser and this runs the test for chlorine from 14 parts per million at 4 a. m. to 2875 parts at 11 a. m. Condenser water and other industrial wastes dilute the sewage far beyond the municipal average.

The comparative tests are made with (1) activated sludge, (2) Imhoff tank, (3) screening, and (4) Miles-acid. The effluent of all except the Miles process is disinfected by chlorine.

Results in Sedimentation and Bacterial Count

The activated sludge process is too expensive for the purpose and the presence of copper from the munition works and other industrial wastes seem to interfere with the biological conditions demanded by it. The Imhoff tanks give good results in regard to clarification. The accumulation of sludge was less than anticipated. The screening tests were not satisfactory and gave a recovery of less than 10 per cent of the solids.

The Miles tank 4 x 4 x 16 ft. cares for 10,000 gallons daily and has been in operation during the last run from January 26. On March 30 it was still going. There is no sludge on the surface, no gas, and no septic condition. Only 700 lb. SO_2 per 1,000,000 gallons is

used, in view of factory wastes. The effluent is satisfactory and it is exceedingly convenient to handle the deodorized sludge. That which has not been degreased has, after 2½ months, only a slight earthy odor.

With the Imhoff tank the average reduction for November, December and January of suspended solids was 46 per cent. and of settleable solids 83 per cent. The bacteria per cc. at 20 deg. C. were 506,700 in the influent and 640,440 in the effluent while the average gas-formers were respectively 14,920 and 10,530.

With the Miles acid process the average of three tests of 25 days in June, 24 days in July and 44 days in November and December showed a reduction of 59 per cent suspended solids, and 87 per cent settleable solids; while the bacteria per cc. decreased from 558,000 in the raw to 8,000 in the effluent, or 98.5 per cent and gas-formers decreased per cc. from 19,860 to 160 or 99.2 per cent. The wet sludge contained 86.9 per cent moisture and there was 3630 lb. wet and 475 lb. dried sludge per million gallons. The ether extract was 26.5 per cent of dry sludge or 121 lb. per million gallons.

In regard to the bacteria it is noted that the pressure of the SO_2 from the pressure tanks which served for the supply varies with the temperature; that occasionally, despite hourly tests, the acidity would get very low and that frequent adjustments of the valves were necessary. The acidity of many samples tested was below 50 parts per million, and if these tests were discarded the bacterial count would be much lower.

It will be observed that this sewage is remarkably dilute, producing but 475 lb. dried sludge to the million gallons against 1909 lb. found in Boston sewage by Professor Weston. The large proportion of fats in the sewage is confirmed, but the quality of the fats present is seriously affected by the mineral oils contributed from industrial sources. Several laboratories now have samples of the grease under examination. In order to study another type of sewage a small tank with 5000 gallons daily capacity is being tested at the mouth of another sewer, which drains houses and several large laundries, but no manufacturing establishments. This sewage requires far more acid and yields grease of a better quality. The results of these studies will not be known for several months.

The New Haven experiment seems to be bringing the available systems down to Miles-acid and Imhoff tanks. The Imhoff tanks leave the sludge still to be disposed of, which is a difficult and septic mess to handle. The chlorination of the effluent is also expensive. Against this there is the Miles process, with inoffensive sludge and the effluent already sterilized. The sludge will probably have no value unless it is degreased and the question then remains whether there is enough fertilizer and enough grease to pay for the plant. The cost of acidulation varies with the alkalinity of the sewage, while the cost of chlorination of Imhoff effluent is less variable. It is, as we observed before, a problem in chemical engineering and, as Professor Winslow (from whom we gathered the idea) says, "The sanitary engineer should have called the chemical engineer into his counsel long ago, for the problem of today is not how to get rid of things so much as it is how to use them." We agree with him entirely.

There is no conclusion to this article, because the work is not finished, and the acid treatment of sewage is still in the promotion stage. What seems to be brought out is that the SO_2 acidulation of sewage is a considerable contribution to the reduction of offense. The cost of plant and operation and the returns that may be expected are variable because no two sewers are precisely alike in their burdens; but all the problems presented are easy to solve by competent chemical engineers, provided always politics do not enter into the sewage and undo all the good that either chlorine or SO_2 can bring about.

Regulations Concerning Exports to Great Britain, Italy and Belgium

THE War Trade Board announces after consultation with the United States Food Administration, the United States War Industries Board, and the Missions of the respective European allies, that for the purpose of preventing the useless consumption of materials and labor in making articles for export which for the present may not be exported, and for the purpose of saving tonnage by prohibiting the exportation of articles which have not been recommended by the Government of the country of destination as being necessary for their essential requirements, the War Trade Board has adopted the following additional rules and regulations with respect to the issuance of licenses to export any commoodity to the United Kingdom, France, Italy and Belgium (excluding their respective colonies, possessions and protectorates).

On and after May 15, 1918, applicants, before filing applications for licenses to export any commodity to the above named countries, must obtain thereon the written approval of the mission in the United States of the country to which the exportation is to be made. To secure this approval, applicants should forward their applications, duly executed, in triplicate, with proper supplemental sheets attached thereto, including Supplemental Sheet X-11 or X-12, as may be required, to:

The British War Mission, Munsey Building, Washington, D. C. For shipments to the United Kingdom.

The French High Commission, 1954 Columbia Road, N. W., Washington, D. C. For shipments to France.

The Italian High Commission, 1712 New Hampshire Ave., N. W., Washington, D. C. For shipments to Italy.

The Belgian Commission, Room 202, Council National Defense Bldg., Washington, D. C. For shipments to Belgium.

One copy of approved applications will be forwarded by the Missions directly to the War Trade Board, Bureau of Exports, Washington, D. C.; one copy retained; and the other copy returned to the applicant for his convenience in keeping a record.

Applicants will be required to agree with the War Trade Board not to purchase nor acquire for export nor take any steps in the process of producing manufacturing or fitting for export the articles specified in the application until an export license has been duly granted.

On the Molecular Physics of Ore Flotation[1]

BY WILL H. COGHILL[2] AND C. O. ANDERSON[3]

INTRODUCTORY

IT IS COMMON practice to inquire into the efficiency of a process as soon as it has been made commercially successful. So it has been with the flotation process. Hoover[4] makes an erroneous statement about the force required to penetrate a liquid surface, and with it as a basis calculates and tabulates the actual and theoretical capacities of several types of flotation machines. Other writers have made similar efforts by using principles incorrectly. The most striking case is that of Van Arsdale.[5] He begins with the premise that "the maximum weight that can be supported on the surface of water is equal to the surface tension of the area supporting the weight." Beginning thus with a false premise, naturally he ends with false conclusions. It is scarcely hypercritical to say that for these fallacies to go unchallenged after receiving favorable editorial comments and being incorporated in a book, portends a tardy science of flotation.

In this discussion the underlying principles involved in calculating the flotability of solids and constructing profiles arising from surface tensions will be pointed out and the calculation of "theoretical capacities" left to the more ambitious.

MAXIMUM DEPRESSION AGAINST A VERTICAL PLATE

Imagine a plate of unit horizontal length placed vertically with its lower edge below the surface of water with its faces so prepared that on one side $\theta = 90°$ and on the other, $\theta = 180°$, (θ is the angle of contact). It will appear in cross section at right angles to its length as shown in Fig. 1. Let h be the depth of the dimple in centimeters. It is obvious that the sum of the horizontal forces must be zero, otherwise there would be motion, and work would be done without the expenditure of energy, which is contrary to the laws of nature.[6]

Since, on one side, the surface of the dimple meets the plate at 180°, the horizontal component of the pull due to surface tension is zero. On the other side, it is 0.0715 gram (the assumed tensile strength of the film). Opposite and equal to this force is that of the head of the water from *a* to *b*, which is

$$h \times \frac{h}{2} = \frac{h^2}{2};\ \frac{h^2}{2} = 0.0715$$

$h_2 = 0.143.$

$h = 0.378$ centimeter, the maximum depth possible in pure water where the face is vertical.

MAXIMUM RISE AGAINST A VERTICAL PLATE

The profile of the liquid surface wetting the glass, Fig. 2, is the inverted profile of the one where $\theta = 180°$ in Fig. 1, because hydrostatic pressure is the only variable, and it varies directly with depth—from the top of the meniscus in Fig. 2 to the bottom of the dimple in Fig. 1. The maximum rise is therefore 0.378 centimeter. The radius of curvature at any point is determined by the formula

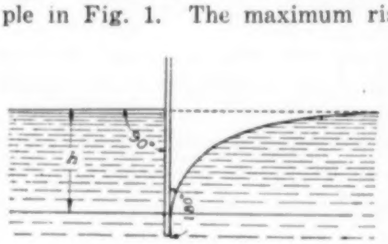


Fig. 1
Vertical plate with faces prepared so that θ is 90° and 180°

$$P = \frac{T}{R}$$

Note that in Fig. 1, where h was found to be 0.378 centimeter, the solid face was vertical. The maximum depth is obtained when the non-wetted face is horizontal. Let this depth be H.

PROFILE OF A DROP OF WATER

If the liquid is resting on a solid which it meets at an angle of 180°, the drop will appear as shown in Fig. 3. The total hydrostatic pressure against an imaginary vertical plane of unit horizontal length against the right end is $\frac{H^2}{2}$. The opposite and equal force is 2 T, where T is the tensile strength measured in gram-weight per unit-length of film.

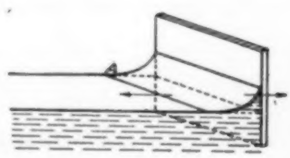


Fig. 2
Capillary rise against a vertical plate

$$\therefore \frac{H^2}{2} = 2T,\ H^2 = 4T = 0.286$$

$$H = 0.535 \text{ centimeter.}$$

To draw this, take a horizontal line to represent the upper plane surface. Having the value of H, take another line to represent the surface of the solid on which it rests. Let the surface of the water meet the solid surface at A. The radius of curvature R of the surface of the water where it leaves this solid is found by substituting the values for T and H in the formula for radius of curvature as given above.

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[1]Published in the *Journ. Phys. Chem.*, April, 1918, by permission of the Director of the U. S. Bureau of Mines.

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[3]"Fellow," College of Mines, University of Washington.

[4]T. J. Hoover: "Concentration of Ores by Flotation," p. 77 (1914).

[5]G. D. Van Arsdale: "How Flotation Works," Eng. & Min. Jour., 101, 851 (1916).

[6]The equilibrium of this system and the one in Fig. 2 was discussed by Le Conte and Riley in the Philosophical Magazine in 1883. Le Conte fell into a dispute with Young, who "insisted that according to Laplace's theory the horizontal molecular pressures on the opposite faces being unequal, the composite plate should be drawn in the direction of the center of concavity of the meniscus on the glass face (Fig. 2),and thus cause the entier system to take on a motion of translation.

He, therefore, "made the following arrangements with the view of experimentally testing the question: A plate of well cleaned glass and a plate of polished steel were cemented together so as to constitute a composite plate of these substances. This was floated in a vertical position by securing masses of cork to the two faces, and attaching a leaden sinker of the proper weight to the lower extremity of the plates. If such a composite plate is plunged vertically into alcohol contained in a large vessel, a concave meniscus will be formed by the ascending liquid on the glass face, while on the steel face no meniscus will be formed, and the adjacent surface of the alcohol will be horizontal." There was no evidence of unbalanced forces on the floating faces.

Riley investigated this principle and included conditions represented by Fig. 1 and found that in "every case the identity shows that the magnitude of these tensions is just the same as if the surfaces came up perpendicular to the plates without elevation or depression."

$$P = \frac{T}{R} = H$$

$$0.535 = \frac{0.0715}{R}$$

$$R = 0.134 \text{ centimeter.}$$

From "A" measure a distance R vertically upward, and with the point so chosen, describe a small circular arc radius R, to represent the lowest arc of the profile. The remaining arcs of the profile are drawn as indicated by the figure.

It is not absolutely correct mathematically to apply the formula

$$P = \frac{T}{R}$$

in this case. It is correct only when a surface element is obtained by bending a flat surface about a straight

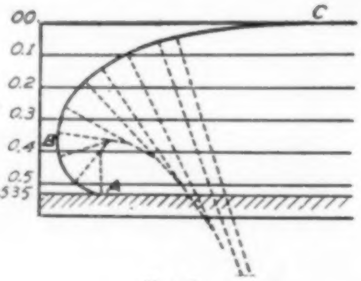


Fig. 3
The arc method of constructing the profile of drops of water

line as an axis, *i. e.*, only one plane of bending, giving a cylinder. With the flattened drop there are really two planes of bending at right angles to each other, and when the radii are R_1 and R_2, the correct formula is

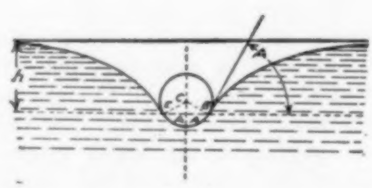
$$P = T\left(\frac{1}{R_1} + \frac{1}{R_2}\right)$$

Generally, however, R_2 is so large that $\frac{1}{R_2}$ may be neglected. When $R_1 = R_2$, we have, of course, the spherical drop.

The Proverbial Steel Needle

The following demonstration of equilibrium of the floating needle is taken from Edser:[7]

Let Fig. 4 represent the transverse section of a needle of radius r, floating on water. Let the surface of the water leave the needle tangentially at B, where the radius CB of the needle makes an angle A with the vertical. Let the point B be at a distance, h, below the flat surface of the water.



Transverse section of wire floating on water when θ is 180°

The following are the upwardly directed forces acting on unit length:

The force due to the surface tension of the water is equal to

$$2\ T \sin A \qquad (a)$$

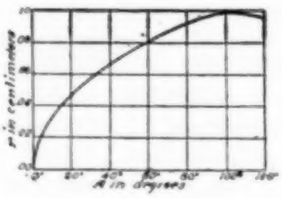
If the portion of the needle below the horizontal plane EB were removed, the hydrostatic pressure of the water would exert an upward force equal to

$$2\ r \sin A\ h \qquad (b)$$

The additional upward force due to the segmental portion of the needle below EB is equal to the weight of the water displaced by this portion of the needle; that is,

$$r^2\left(\pi \cdot \frac{A}{180} - \sin A \cos A\right) \qquad (c)$$

It is assumed that the length of the wire in comparison with the diameter is so great that the surface-tension pull upon the ends may be neglected.



Graph showing relation of r and A for steel wire on water where θ is 180°

The downward force is

$$7.7 \cdot \pi\ r^2 \qquad (d)$$

We now wish to eliminate h in Equation b. Inspection shows that for horizontal forces in FB to be in equilibrium,

$$\frac{h^2}{2} = T - T\cos A$$

$$h = 2\sqrt{T}\sqrt{\frac{1 - \cos A}{2}}$$

$$= 2\sqrt{T}\sin\frac{A}{2} \qquad (e)$$

Substituting this value for h in equation b and equating the upward and downward forces, we obtain the equation

$$2T\sin A + 4r\sin A\sin\frac{A}{2} \cdot \sqrt{T} +$$

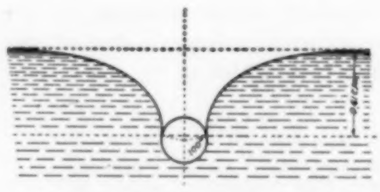
$$r^2\left(\pi \cdot \frac{A}{180} - \sin A\cos A\right) = \pi r^2\, 7.7$$

Setting $\sin A \cos A$ equal to $0.5 \sin 2A$ $\qquad (f)$
and transforming,

$$r^2\left(24.2 + 0.5\sin 2A - \pi \cdot \frac{A}{180}\right) - 1.07r\sin A\sin\frac{A}{2}$$

$$= 0.143 \sin A \qquad (g)$$

Fig. 5 shows the values of r for values of A lying between 0° and 120°. It will be noted that the maximum value of r corresponds to A = 100°, and is equal to 0.0995 centimeter, or roughly 1 mm. Thus the diameter of the largest needle that can float on water is equal to two millimeters approximately. The position of the needle relative to the surface is shown in Fig. 6. The curve in Fig. 5 shows that the needle is in unstable equilibrium when A is greater than 100°.



... 180° and r is a maximum

Liquid Profiles.

A method of constructing liquid profiles is shown in Fig. 3. Its inaccuracy becomes apparent when one attempts to apply it; there is a cumulative error which necessitates "fudging" the curve to make it become tangent at "C." An exact method is desirable.

[7] Edwin Edser: "General Physics for Students," p. 340 (1911).

A search of the scientific literature reveals the fact that some of the scientists have been unable to deal with this curve in a scientific manner, using instead "cut and try" methods. A striking example of this is found in the paper of Richards and Coombs,[8] where they made elaborate experiments to "discover" the "diameter necessary in order to attain the flat surface with which the capillary rise is to be compared" while measuring surface tension by the capillary rise method. After investigating the literature and making many tests, they decided that "in the 38 mm. tube, a portion in the middle, apparently about 5 mm. in length, appeared to be flat, coinciding exactly with the horizontal spider-line of the telescope." From this it appears that in a a large glass receptacle where θ is zero, or nearly so, the meniscus would coincide with the plane surface of the liquid at a distance 16.5 millimeters $\left(\frac{38-5}{2}\right)$ from the wall. Since the upper portion of the profile (that above B) in Fig. 3 is like the inverted profile of the meniscus referred to, it would be expected therefore that the horizontal distance from B to C would be 1.65 centimeters. The error in the conclusions of Richards and Coombs is indicated below.

Construction of Profile Based on a Co-ordinate System

A comparison of the theoretical and observed positions of floating cylinders where the specific gravity, angle of contact and surface tension are known would add to the significance of these factors when applied to the study of floating minerals. To do this a correct liquid profile must be constructed by means of co-ordinates. Gray's[9] work aids in this regard. Under the subject of capillarity he gives the equation of this curve but treats it so academically that one finds it difficult to make the technical application. His equation is

$$x = -(4a^2 - y^2)^{\frac{1}{2}} + a \log \frac{2a + (4a^2 - y^2)^{\frac{1}{2}}}{y} + C$$

It is interesting to note at this point that Lord Kelvin

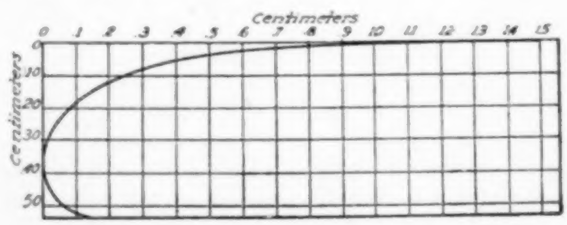


Fig. 7
Profile of standing water with one plane of bending.
T = 0.0715 gram

and Tait[10] have likewise applied this equation to the curve of a bent wire. Hall[11] has also used it. If we set $2a = 0.535$ (the value of H), $C = 0.1427$ and change the Napierian logarithm to the common system by multiplying by 2.3, it takes the form

$$x = -(0.2862 - y^2)^{\frac{1}{2}} + 0.6152 \log \frac{0.535 + (0.2862 - y^2)^{\frac{1}{2}}}{y} + 0.1427$$

Table I gives the x, y ordinates.

The remarkable coincidence of this curve (Fig. 7), with the portion of Fig. 3 in which the arc method of construction has the minimum error, and the deviation from it where the error is obviously maximum, dispels all doubt toward the application of the formula to the profile of a standing liquid with one plane of bending.[12]

TABLE I. CO-ORDINATES FOR LIQUID PROFILE WHERE THERE IS ONLY ONE PLANE OF BENDING

T = 0.0715 g, sp. gr. = 1

x	y	x	y
0.143	0.535	0.1828	0.13
0.0809	0.52	0.2032	0.12
0.0645	0.51	0.2240	0.11
0.0517	0.50	0.2479	0.10
0.0332	0.48	0.2749	0.09
0.0149	0.45	0.3052	0.08
0.0050	0.42	0.3409	0.07
0.0011	0.40	0.3799	0.06
0.0000	0.378	0.4278	0.05
0.0018	0.35	0.4768	0.04
0.0085	0.32	0.6714	0.02
0.0154	0.30	0.8663	0.01
0.0244	0.28	0.9331	0.0075
0.0421	0.25	1.0015	0.0050
0.0580	0.23	1.2266	0.0025
0.0746	0.21	1.3630	0.0015
0.0843	0.20	1.4710	0.0010
0.1199	0.17	1.5480	0.00075
0.1496	0.15	2.0866	0.00010
0.1671	0.14	......	......

Reference to the last two values of y and x in Table I shows that the 1.65 centimeters, taken by Richards and Coombs as the distance from the solid at which the meniscus coincides with a plane surface, allows an error of less than 0.00075 centimeter and more than 0.00010 centimeter. This appears in Fig. 7 and Table I.

Having this curve, we can now consider the angle of contact.

The Practical Formula for Steel Wires Floating on Water.

In the formula developed for the floating "needle," θ was taken as 180°. Since this value is likely never found in practice, it must be regarded as ideal. By a simple substitution a variable which will make it applicable for all values of θ is introduced, after which theoretical and observed values may be compared.

The corrections are simple, though at first somewhat confusing.

Since, in practice, the angle of contact is always less than 180°, an angle D is introduced to represent this difference. Equation a then becomes,

$$2T \sin (A - D) \qquad (a')$$

Equation e becomes

$$2\sqrt{T} \sin \frac{A - D}{2}$$

and when this value is substituted in (b) we have

$$4r\sqrt{T} \sin A \sin \left(\frac{A - D}{2}\right) \qquad (b')$$

The expressions (c) and (d) are unchanged.

Equation g, which applies to steel wires, then becomes

$$r^2\left(24.2 + 0.5 \sin 2A - \pi \frac{A}{180}\right) - 1.07r \sin A \sin \left(\frac{A - D}{2}\right) = 0.143 \sin (A - D) \qquad (g')$$

Table II gives the values of A and r for stated values of θ.

Fig. 8 shows the curves conforming to the co-ordinates given in Table II.

[8]T. W. Richards and L. B. Coombs: "The Surface Tension of Water and the Alcohols," Jour. Am. Chem. Soc., 37, 1656 (1915).

[9]A. Gray: "A Treatise on Physics," 1, 651.

[10]Lord Kelvin and P. Tait: "Treatise on Natural Philosophy," Part 2, p. 149.

[11]T. P. Hall: Phil. Mag., 36, 385 (1893).

[12]This equation will be treated in more detail by one of us (A) in another paper. There it will be shown how the two parameters used in the graphical construction of the curve are incorporated into the equation.

TABLE II. VALUES OF A AND r IN EQUATION g'. STEEL WIRES

θ = 180° D = 0°		θ = 168° D = 12°		θ = 150° D = 30°		θ = 135° D = 45°		θ = 105° D = 75°		θ = 90° D = 90°		θ = 75° D = 105°		θ = 45° D = 135°	
A	r cm	A	r	A	r	A	r	A	r	A	r	A	r	A	r
0	0.0000	...	......	...	......	...	......	...	......	...	......	...	......	...	......
10	0.0320	...	......	...	......	...	......	...	......	...	......	...	......	...	......
...	......	12	0.0000	...	......	...	......	...	......	...	......	...	......	...	......
20	0.0461	20	0.0291	...	......	...	......	...	......	...	......	...	......	...	......
30	0.0572	30	0.0444	30	0.0000	...	......	...	......	...	......	...	......	...	......
40	0.0667	40	0.0563	40	0.0333	...	......	...	......	...	......	...	......	...	......
...	......	...	......	...	......	45	0.0000	...	......	...	......	...	......	...	......
50	0.0752	50	0.0660	50	0.0482	50	0.0234	...	......	...	......	...	......	...	......
60	0.0829	60	0.0753	60	0.0602	60	0.0421	...	......	...	......	...	......	...	......
70	0.0895	70	0.0829	70	0.0704	70	0.0553	...	......	...	......	...	......	...	......
...	......	...	......	...	......	...	......	75	0	...	......	...	......	...	......
80	0.0941	80	0.0896	80	0.0792	80	0.0668	80	0.0242	...	......	...	......	...	......
90	0.0976	90	0.0946	90	0.0864	90	0.0765	90	0.0435	90	0.0000	...	......	...	......
100	0.0994	100	0.0979	100	0.0921	100	0.0839	100	0.0573	100	0.0345	...	......	...	......
...	......	...	......	...	......	...	......	...	......	...	......	105	0.0000	...	......
110	0.0987	110	0.0989	110	0.0957	110	0.0897	110	0.0682	110	0.0510	110	0.0247	...	......
120	0.0961	120	0.0981	120	0.0974	120	0.0936	120	0.0767	120	0.0630	120	0.0446	...	......
130	0.0906	130	0.0946	130	0.0967	130	0.0947	130	0.0830	130	0.0721	130	0.0572	...	......
140	0.0824	140	0.0885	140	0.0946	140	0.0943	140	0.0869	140	0.0784	140	0.0669	140	0.0248
150	0.0714	150	0.0798	150	0.0880	150	0.0912	150	0.0886	150	0.0828	150	0.0739	150	0.0433
160	0.0570	160	0.0686	160	0.0801	160	0.0857	160	0.0879	160	0.0848	160	0.0784	160	0.0554
170	0.0388	170	0.0547	170	0.0701	170	0.0783	170	0.0853	170	0.0863	170	0.0803	170	0.0635
180	0.0000	180	0.0380	180	0.0580	180	0.0690	180	0.0807	180	0.0821	180	0.0807	180	0.0690

THE RELATION OF ANGLE OF CONTACT TO FLOTABILITY.

We now have sufficient data to show the relation of the angle of contact to the flotability of cylinders. The

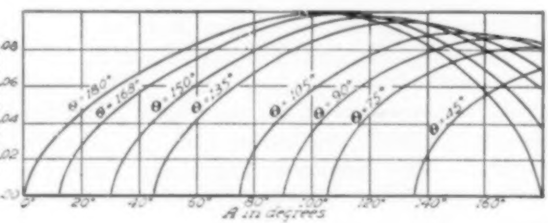


Fig. 8

Curves showing the theoretical values of A for steel wires for stated values of r and θ

subject begins to take the aspect of a science when we see from this figure that if r is sufficiently small a solid is flotable though θ may be as small, for example, as 45° or less. Previously, the fact that pieces of glass floated on water could be explained only by the "air cushion" theory. Such an hypothesis must now give way to facts. Consider, for example, a steel wire with a radius of 0.06 centimeter. Reference to Fig. 8 shows that when θ = 180°, A = 33°; θ = 168°, A = 44°; θ = 150°, A = 60°; θ = 135°, A = 74°; θ = 105°, A = 102°; θ = 90°, A = 117°; θ = 75°, A = 133°; θ = 45°, A = 165°. The very slight drop in the consecutive crests of the curves from left to right, while θ decreases from 180° to

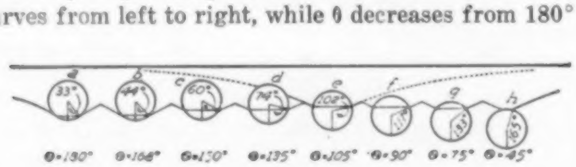


Fig. 9

Showing how a steel wire of given diameter (r = 0.06 cm) rides on pure water while θ decreases from left to right

45°, is striking. But this must not be taken to indicate relative flotability in practice. For, though it is true that increasing "A" brings the object near the point of unstable equilibrium (the descending portion of the curve), yet another factor of no less importance appears in practice. It is the position of the walls of water with reference to the object, and to each other. Note in Fig. 9, *a*, how the object rides safely on a disturbed surface, while in Fig. 9, *h*, there is continual danger of the walls overlapping and causing submergence. When they overlap and coalesce, the surface tension film, of course, vanishes. A little lycopodium powder or talc on the surface assists in maintaining the interface by preventing coalescence. Is it not probable that the insoluble oil used in flotation acts in the same manner, preventing the coalescence of the walls of the bubble whenever it is in danger of being separated from the mineral?

These theoretical considerations would have greater significance if supported by physical measurements and observations. Such tests have been made with the cathetometer, and the agreement of observed and calculated values justifies the theory. Let us first consider the principles involved in constructing Fig. 9, after which we shall consider the physical measurements.

Take, for example, Fig. 9, *b*. The radius of the steel wire is 0.06 centimeter and θ is 168°. The angle D is therefore 12°. Look along the line (Fig. 8), corresponding to r = 0.06 cm. and find where it intersects the curve marked "θ = 168." Here the corresponding angle A is 44°. Now use the modified form of Equation *e*, which is,

$$h = 2\sqrt{T} \sin \frac{A - D}{2}$$

This gives the value of h, which is then applied to Fig. 9. At the point on the curve so determined strike off the radius of the object so that "A" has the value desired, and draw the circle.

Of course, θ must be determined by test. The classic methods for this determination were considered, but discarded in favor of an indirect method in which the cathetometer was used. Here the capillary rise or depression against a vertical plane surface was determined, and θ was found by means of the above equation by solving for D after setting A equal to 90°. When there is capillary rise, θ equals D, and for capillary depression θ equals 180° minus D. Pure water gives an angle of contact of 168° against a surface prepared by dipping a solid into molten paraffin and sprinkling lycopodium powder on it before the paraffin congeals. Against solid paraffin the angle is 105°.

Table III shows that the observed and theoretical position of steel wires floating on pure water coincide with a satisfactory degree of accuracy. The cathetometer was used to measure the vertical distance from the plane surface of the water to the bottom of the floating wire. No correction was made for the thickness of the paraffin shell, which was found to be very thin—only 0.01 centimeter. Fig. 10 shows the theoretical position of these wires on the liquid profile. The liquid

meets the heavy and dotted circles at 168° and 105°, respectively.

TABLE III. SHOWING THE OBSERVED AND THEORETICAL DEPTH OF STEEL WIRES FLOATING ON PURE WATER

Radii of Wires in Centimeters	θ = 168 Depth in Centimeters		θ = 105 Depth in Centimeters	
	Observed	Theoretical	Observed	Theoretical
0.0440	0.090	0.082	0.120	0.115
0.0520	0.125	0.129	0.160	0.156
0.0684	0.205	0.212	0.260	0.253
0.0855	0.330	0.335	......	......

The Flotation of Aluminium Wires

From the standpoint of the metallurgist, we are still dealing with an ideal case because minerals cannot be obtained in the form of right circular cylinders; again,

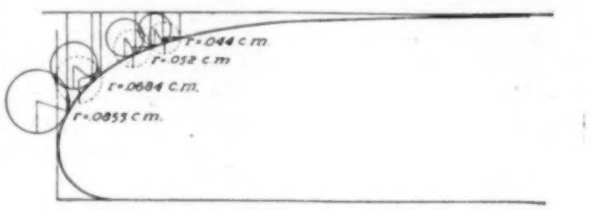


Fig. 10
Theoretical positions of steel wires floating on water where T is 0.0175 and θ is 105° and 168°, respectively

steel wires have a greater specific gravity than many of the metallic sulphides. In order to transform ideal conditions into the practical, let us make a further study of the effect of specific gravity, reserving the question of shape of the floating object for a later discussion.

Having made a study of the conduct of wires heavier than the average of the metallic sulphides, it seems that if we would make a similar study of those lighter than the minerals and find an agreement also between theoretical and observed values, we could use mathematical processes for predicting the conduct of any mineral. The following results deal, therefore, with aluminium wires:

When aluminium wires (specific gravity 2.7) are used, the equation corresponding to Equation g' is

$$r^2\left(8.4823 + 0.5\sin 2A - \pi\frac{A}{180}\right) - 1.07r\sin A\sin\left(\frac{A-D}{2}\right)$$
$$= 0.143\sin(A - D)$$

The values of A and r for stated values of θ are shown in Table IV.

TABLE IV. VALUES OF r AND A ALUMINIUM WIRES

θ = 168°, D = 12°		θ = 105°, D = 75°		θ = 90°, D = 90°	
A	r	A	r	A	r
12	0.0000	...	......	...	......
20	0.0499	...	......	...	......
30	0.0775	...	......	...	......
40	0.1004	...	......	...	......
50	0.1216	...	......	...	......
60	0.1422	...	......	...	......
70	0.1626	...	......	...	......
	......	75	0.0000	...	......
80	0.1812	80	0.0446	...	......
90	0.1986	90	0.0835	90	0.0000
100	0.2129	100	0.1145	100	0.0686
110	0.2210	110	0.1410	110	0.1033
120	0.2262	120	0.1630	120	0.1312
130	0.2217	130	0.1795	130	0.1531
140	0.2083	140	0.1892	140	0.1686
150	0.1860	150	0.1931	150	0.1771
160	0.1564	160	0.1870	160	0.1769
170	0.1182	170	0.1761	170	0.1733
180	0.0744	180	0.1602	180	0.1631

These points are plotted in Fig. 11. The scale is the same as that of Fig. 8. Note how they have the same general form as those for steel, but run up much higher on account of the lesser density of the aluminium. The remarkable coincidence of the theoretical depth with the observed depth of the bottom of the wire below the plane surface of the liquid again substantiates the theory. See Table V.

TABLE V. SHOWING THE OBSERVED AND THEORETICAL DEPTH OF ALUMINIUM WIRES FLOATING ON PURE WATER

Radii of Wire in Centimeters	θ = 168° Depth in Centimeters		θ = 105° Depth in Centimeters	
	Observed	Theoretical	Observed	Theoretical
0.065	0.067	0.065	0.102	0.100
0.095	0.136	0.140	0.190	0.195
0.192	0.494	0.500	......	......
0.215	0.680	0.642	......	......

Fig. 12 shows the theoretical position of these aluminium wires on the liquid profile. The liquid meets the

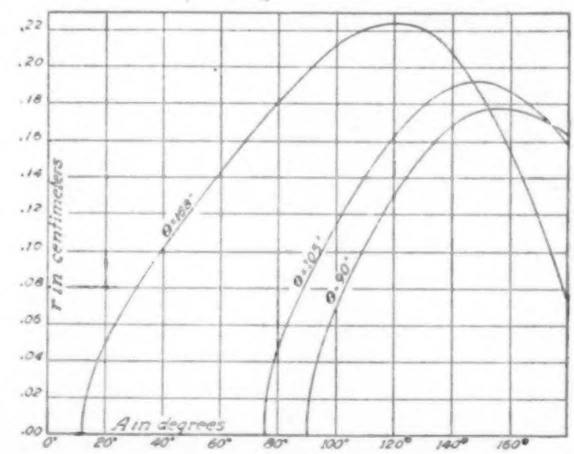


Fig. 11
Curves showing the theoretical values of A for aluminium wires for stated values of r and θ

heavy and dotted circles at 168° and 105°, respectively, as in Fig. 10, where the steel wires were shown.

Anderson[13] says: "A needle, especially if slightly oily, will float if carefully placed upon water. We may note in passing that the weight of the water displaced by the sagging of the surface film is equal to the weight of the needle (Archimedes' Principle)." This statement will be discussed in another paper.

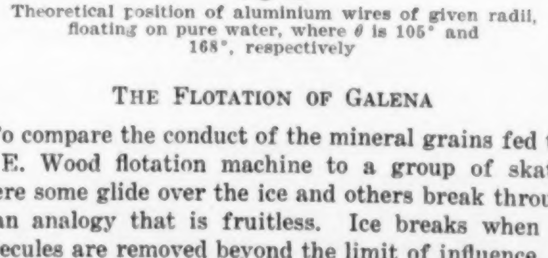


Fig. 12
Theoretical position of aluminium wires of given radii, floating on pure water, where θ is 105° and 168°, respectively

The Flotation of Galena

To compare the conduct of the mineral grains fed to a H. E. Wood flotation machine to a group of skaters where some glide over the ice and others break through, is an analogy that is fruitless. Ice breaks when the molecules are removed beyond the limit of influence, but at the instant when galena sinks the molecules in the surface of the liquid are under the same stress as those on an undisturbed surface. To speak of the membrane rupturing or breaking at the instant the galena becomes submerged, is as far from accuracy as is the

[13] W. B. Anderson: "Physics for Technical Students."

North from the South. We must have the facts or continue the guessing process in flotation, which, it must be admitted, has, in some cases at least, produced such favorable results that a "small piece of cheese has been left for the cats after the monkey got his portion."

What is the position of floating galena relative to the liquid profile? The angle of contact of pure water against cleavage face is approximately 45°. Is a mineral flotable when the water turns up at this angle to meet a vertical face? Figs. 8 and 9 show that wires are, and it seems consistent to assume that the same conclusion applies to minerals. Conjecture offers only one explanation—diagrammed in Fig. 13. Cathetometer observations show that this is a reality. The liquid profile meets the upper horizontal face (at 45°), the proof of which is shown in Table VI.

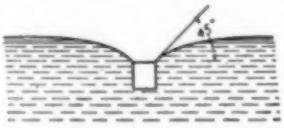


Fig. 13
Diagram showing how galena floats on water when θ is 45°

TABLE VI. CATHETOMETER OBSERVATIONS ON FLOATING GALENA

Approximate Mesh	Vertical Dimensions in Centimeters: Of Galena	Vertical Dimensions in Centimeters: Bottom of Galena to Intersection of Liquid Profile With Galena
36-mesh	0.040	0.055
33-mesh	0.045	0.055
13-mesh	0.130	0.150
12-mesh	0.140	0.150

In each observation the readings showed that the mineral was wholly below the bottom of the dimple.

Summary

The maximum rise and depression of a given liquid against vertical plates are determined and shown to be the same for angles of contact of 0° and 180°, respectively. The horizontal pull of the film is independent of the angle of contact.

A graphical method of constructing a liquid profile with one plane of bending is reviewed.

A review is given of the mathematical discussion of the floating needle when the angle of contact is ideal.

A liquid profile with one plane of bending is constructed on a co-ordinate system, and compared with the arc and "cut and try" methods.

A practical formula for steel wires floating on water is developed from the ideal and theoretical and observed values are compared.

A formula is developed for calculating angle of contact from the cathetometer measurements of rise or depression of a liquid against a vertical plate. The relation of angle of contact to flotability is indicated by curves and checked by observations.

The flotation of aluminium wires is treated scientifically and practically.

The manner in which "floating" galena is suspended at the surface of water is shown.

Brazil Subsidizes Caustic Soda.—Owing to the impossibility of obtaining supplies, the Brazilian Government has just published a decree offering financial assistance to establish caustic-soda factories, loaning up to 75 per cent of cost of construction, the amounts not to exceed $500,000 for each of the first three factories with minimum production of 500 tons per year.

Research Fellowships in Metallurgy School of Mines, University of Idaho

In co-operation with the United States Bureau of Mines, the University of Idaho, through the generosity of the mine owners of the state, offers in the School of Mines a number of fellowships in metallurgy. These fellowships are open to college graduates who have had good training in chemistry and metallurgy, and who are qualified to undertake research work. The income of each fellowship is $720 a year of twelve months beginning July 1st, 1918.

Fellows will register as students in the University of Idaho and become candidates for the degree of Master of Science in Mining or Metallurgy (unless this or an equivalent degree has been earned.) Their class work will be directed by the heads of the departments of instruction, but the greater portion of their time will be spent in research work under the direction of the Bureau of Mines staff resident at the University. The purpose of this work is to undertake the solution of definite problems confronting the mining and metallurgical industries of the state of Idaho. For 1918-19 the following subjects are to be investigated:

(1) Differential flotation—with especial reference to the zinc-lead ores of the Coeur d'Alene.

(2) Availability of western wood-oils for flotation concentration.

(3) Treatment of the complex gold-silver ores of southern Idaho.

Under the ruling of the War Department candidates 21 years of age or over who are accepted for the fellowship, will be allowed to enlist in the Engineers Reserve Corps detailed to continued their studies, and placed in a deferred classification for the period of their enrollment as graduate students.

Applications, with certified copy of collegiate record, and names and address of three references will be received up to June 1st, 1918. The applications should be addressed to The Dean, School of Mines, Moscow, Idaho.

Kaiser Wilhelm Trust for Promotion of the Science of War

The Kaiser has approved the foundation of a Trust with the name given above. The aim of the Trust is to further the development of scientific and technical aids to warfare, by uniting the scientific and the military forces of the country for work together. The scientific work is to be carried on by the following technical committees (or commissions):

(1) Committee for the chemical raw materials, for the production of munitions-manufacturing materials.

(2) Committee for chemical war materials (powder, explosives, gas, and the like).

(3) Committee for physics, including balistics, telephony, telegraphy, determination of targets and distances, measurements, and the like.

(4) Committee for engineering and communication.

(5) Committee for aeronautics.

(6) Committee for obtaining and preparation of metals.

The Economic Position of Oil Shales

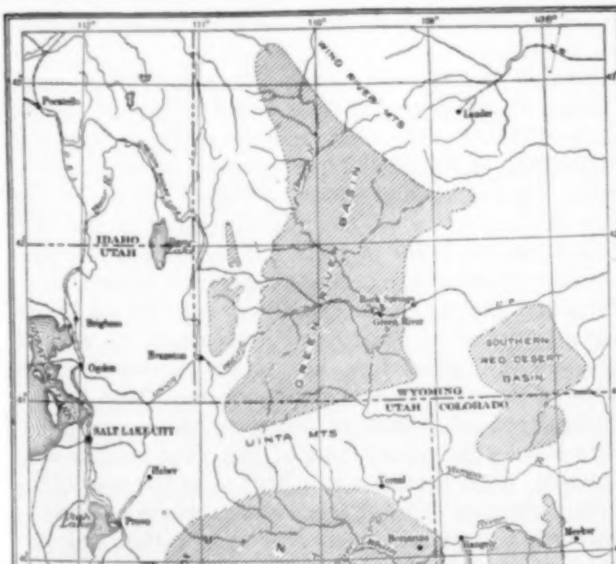
Economic Distribution, Methods of Production and Comparative Yields

BY JAC C. MORRELL AND GUSTAV EGLOFF

THE increasing need of petroleum oil is steadily outdistancing the visible supply to such an extent that the oil shales of the West are already being considered not only to make up a developing shortage, but as the future oil reserve. Various statistics show that since 1913 the consumption of petroleum crude oil has grown faster than production at the wells in the United States. The Government has classified 3,692,036 acres as oil-shale land in the West. During the last year two oil-shale reserves were created for the use of the navy, one of 45,440 acres in Colorado, and one of 86,584 acres in Utah.

Statistical Situation

In Senate document 310 it is indicated that the maximum amount of oil in the known oilfields would yield 7,629,000,000 barrels. From 1859 to Jan. 1, 1918, the total number of barrels of crude petroleum oil produced in the United States was 4,200,000,000. From a production of 2000 barrels in 1859 the number increased to 286,000,000 in 1917. M. L. Requa has stated that by assuming the annual increase as 5 per cent of the previous year's production, there would be required in 1925 409,000,000 barrels of crude oil. In 1917 the production of crude oil was 286,000,000 barrels, and, according to the Geological Survey, there is only 7,629,000,000 barrels of extractable petroleum oil in the known fields of the United States. Thus there is only a known oil supply available for twenty-three years. This calculation is on the assumption that there is no yearly increased demand for petroleum products. But on the basis of past yearly increase in petroleum consumption the estimated available supply will last probably fifteen years.



KEY MAP OF NORTHWESTERN COLORADO AND ADJACENT AREAS

Assuming that new oilfield deposits and known production may be tripled, our oil supply will last a scant fifty years. It is well known that a number of our oil areas are decreasing yearly in production, and although the total barrels of crude oil production increases yearly, the amount is not great enough to supply the demand for refined products. Hence, the necessity of taking crude oil from storage. On Jan. 1, 1916, 198,000,000 barrels of crude oil and on Jan. 1, 1918, approximately 155,000,000 barrels were in storage, which shows a depreciation of 43,000,000 barrels, leaving less than a six months' supply of crude oil above ground for refining. In 1917 there were 359 refineries in operation, with a yearly capacity of 450,000,000 barrels of crude oil.[1] At the present time there are 118 new refineries building, with a yearly capacity of 40,000,000 barrels. In the year 1918 there will be operating 477 refineries, with a yearly capacity of 490,000,000 barrels.

The United States production of petroleum crude in 1918 will be 300,000,000 barrels. The addition of 50,000,000 barrels from Mexico will give a total of 350,000,000 barrels, but this quantity will not keep the refineries at capacity operation, unless several Cushing, Towanda and Eldorado pools are brought in or the difference be piped from Mexico's prolific field to meet the increasing demand for refined petroleum products. Although the petroleum crude oil of the United States may be exhausted in fifty years, one must not forget the vast deposits in Mexico. For the year 1916 Mexico shipped 40,000,000 and in 1917 50,000,000 barrels of crude oil to the United States. At the present time Mexico has a potential of at least 300,000,000 barrels' production a year, which could be moved to the United States if adequate transportation were available. And, furthermore, the resources of the oil deposits of South America have not been tapped as yet for use in the United States.

Importance of Oil Shales

In view of the above facts, the subject of oil shales has become important, and much is being written about it. Most of the literature, however, deals with statistics concerning the oil shales of a particular locality, and very few attempts have been made to co-ordinate the subject as a whole.

Almost all solids capable of giving up oil either by heat treatment, or by the use of solvents, have been

[1]W. C. Teagle, *Oildom* 8, 11, 1918

classified as oil shales, and although the writers make no pretense that a strict classification can be made, yet a treatment of the most important types of solids producing oil referred to as oil shales may help to clear the field a little.

The relations of these various types to one another, their possible mode of origin, their relation to other solid hydrocarbons and to petroleum, with a discussion of the economic distribution and treatment of oil shales, and the uses of their products, have been correlated by the writers.

Clays, Shales and Slates

The name clay is applied to argillaceous or sedimentary deposits still retaining enough moisture to be plastic. By loss of this uncombined water these clays pass into mudstones, shales and slates. When these fine-grained rocks are composed of sand or limestone sediments they are termed argillaceous sandstones or limestones. A shale is supposed to be a consolidated mud or clay in which the principal constituents are silicates of alumina. As soon as the consolidated clay begins to develop bedding planes and shows a tendency to split along the original laminæ the rock is termed a shale. Further, pressure, sometimes assisted by igneous intrustion, causes a partial change in mineralization, and the original bedding planes are superseded by a new direction of weak cohesion called slaty cleavage, and the resulting rock is called a slate. Pressure alone causes the colloidal particles in muds and clay to cohere, cementation seeming to be a minor factor. The extent to which muds and clays are converted into shales is therefore a function of the pressure. These clays and shales have the property of absorbing petroleum to a limited extent. The adsorptive property of clays and shales for oil has been shown to depend in part on colloid content, which in turn changes with chemical composition.

For comparative purposes Table I tabulates the inorganic content of clays, limestones, shales and similar substances. Some of the spent shales are relatively high in alumina content and may have economic value on that ground, but their importance will lie in the working out of satisfactory cements, clays for pottery, brick and paving material for streets by blending with suitable binders.

Origin of Petroleum

The theories as to the origin of petroleum can be divided into two great classes, namely, the inorganic and organic. The main support of the inorganic theory lies in the fact that hydrocarbons of the acetylene, ethylene and methane series can be produced by the hydrolysis of metallic carbides. The carbide theory has few adherents at the present time. The organic theory is divided into three classes, namely, animal, vegetable, and a combination of the animal and vegetable theories. Under the heading of animal origin of petroleum is the theory that the existence of petroleum is due to the decomposition of marine animals, such as fish, oysters, scallops and a microscopic organism called foraminifera, the latter being found in great quantities along sea coasts in beds hundreds of feet thick. The vegetable theory includes the formation of petroleum from seaweed, land plants and diatoms. The enormous quantity of kelp found along sea coasts lends support to

Table I—Analysis of Clays, Limestones, Shales and Cannel Coal

Type	Per Cent				
	Silica	Alumina	Iron Oxide	Calcium Oxide	Magnesium Oxide
Fire clay (a)	73.82	15.88	2.95	Trace	Trace
Brick clay (a)	49.44	34.26	7.74	1.48	5.14
Average 106 American clays (a)	52.60	21.00	14.80	3.58	2.98
English, Fuller's earth (a)	53.03	10.00	9.75	0.50	1.25
California, Fuller's earth (a)	54.32	18.18	6.50	1.00	3.22
New Brunswick, Can., clay (b)	75.40	11.40	3.50	0.86	1.17
New Brunswick, Can., gypsum (b)	0.30	0.05	0.05	32.30	0.10
New Brunswick, Can., oil shale (b)	30.3	11.50	4.50	6.00	3.50
New Brunswick, Can., spent oil shale (b)	49.6	18.80	7.30	9.90	3.71
New Albany, Ind., black shale (c)	50.5	14.9	....	0.10	0.10
Norfolk English shale (d)	49.5	20.2	10.30	11.70	1.20
Broxburn spent shale (a)	49.72	18.8	16.80	2.40	2.20
Broxburn spent shale (a)	55.97	31.21	2.84	0.59	1.87
Torbanite spent shale (a)	56.70	36.20	3.20	1.30	0.40
Wurtzilite spent shale	36.90	20.57	8.86	11.90	5.30
Wainwright cannel coal (e)	46.20	32.86	13.14	0.49	1.22
Bunceton cannel coal (e)	50.40	19.70	18.90	1.29	1.73
Herrin cannel coal (e)	56.44	12.65	25.71	0.50	0.58

(a) Craig, Jour. Inst. Petr. Techn. 2, 265, 1916.
(b) Ells, Canada Dept. of Mines, Mines Branch 26, 24, 1911.
(c) Forbes-Leslie Jour. Inst. Petr. Techn. 3, 22, 1916.
(d) Ashley, U. S. Geol. Survey, Bull. 641 L, 323, 1917.
(e) Ingram, Bulletin School of Mines, University of Missouri, 3, 24, 1917.

the seaweed theory. It has been clearly shown by numerous investigators that coal is formed from land plants. It is possible that under different conditions petroleum would be formed from plants or that possibly oil was distilled from coal in nature, as may readily be done in the laboratory. It can readily be seen that all possible combinations of the animal and vegetable theory are possible, especially since the remains of animal and vegetable matter are found in the same strata.

The organic matter laid down in beds is prevented from too rapid oxidation by an impervious seal of water overhead, and the formation of oil may be caused by magmatic intrusion under heat and pressure by a process of distillation or diffusion through porous mineral matter.

Oil and gas deposits always occur in higher parts of folds in the earth's surface called anticlines, domes and monoclines. The rocks composing these folds are sedimentary or water laid deposits, such as sands, sandstones, limestones and shales. Water occurs in the same stratum as the oil, but in a lower part of the fold. The oil does not occur in pools, but is retained in reservoirs consisting of coarse sands, porous limestones, sandstones and shales. These deposits retain the oil in the spaces between the grains and are capped, as well as underlaid, by impervious beds, thus preventing the escape of the oil. Some of these caps have been broken and replaced by layers of asphaltic and paraffin deposits left by the evaporation of the more volatile constituents. Such caps give us a hint as to the possibility of the formation of bituminous shales where conditions were such that simultaneous slow evaporation and oxidation of an asphaltic base oil impregnating a shale would leave a product such as is represented by some of our oil shales. This process may have gone on before or after the clay was consolidated into a shale, or the consolidation may have assisted the process.

Some Solid Hydrocarbons

No discontinuity is shown in passing from natural gas through liquid petroleum to solid asphalt and bituminous coal. The physical properties are progressive

in going from gases through liquids and viscous mixtures to solids.[2] All of this suggests a common origin. The solid hydrocarbons found in nature are known generically as bitumens and asphalts. "Bitumen is described as a naturally occurring mixture of native or pyrogenous hydrocarbons and their non-metallic derivatives, which may be gases, liquids or solids soluble in carbon bisulphide and benzol.[3]

The asphalt of Pitch Lake, described by Richardson,[4] is an emulsion of water, gas, bitumen and mineral matter. The gas consists mainly of hydrogen sulphide and carbon dioxide. The analysis of purified Trinidad bitumen is as follows:

	Per Cent
Carbon	82.33
Hydrogen	10.69
Sulphur	6.16
Nitrogen	0.81

Investigation showed that the hardness of bitumen increased with the sulphur content and indicated that sulphur was probably active in hardening the bitumen. Among the most abundantly occurring solid hydrocarbon materials in the United States are gilsonite, tabbyite, wurtzilite, ozokerite and rock asphalt. These substances have varied uses in the industries. Gilsonite is used for paving, insulation, mineral rubber, roofing and water proofing. Tabbyite is used in making mineral rubber; ozokerite or mineral wax, which also occurs in Galicia, Austria, is used in making electrical insulators, and as a substitute for bee's wax. Rock asphalt, a sand conglomerate cemented by bitumen, is used for paving. Bardwell, Berryman, Brighton and Kuhre[5] have compiled some interesting data on the properties of these hydrocarbons. Some of these data are tabulated in Table II.

TABLE II

	Trinidad	Gilsonite	Tabbyite	Wurtzilite	Ozokerite
Bitumen soluble in CS_2	60.36	99.64	94.63	10.83	99.46
Organic matter insoluble in CS_2	3.94	0.0	0.72	87.68	0.50
Inorganic or mineral matter	35.70	0.36	4.65	1.50	0.50
Loss on ignition	64.30	99.64	95.35	98.50	99.96
Fixed carbon	36.69	43.13	37.45	35.60	10.03
Sulphur	4.22	0.52	1.24	4.00	0.29
Total volatile at 400 deg. C.	27.61	56.51	57.90	61.58	87.93

In all cases: streak colored brown, and fracture conchoidal.

Wurtzilite was also found to be very little soluble in naphtha and carbon tetrachloride. It differed from the others by being insoluble in its own distillate and in the distillates of the others.

The case of wurtzilite, which resembles in composition the other hydrocarbons investigated, but differs from them in being practically insoluble in carbon bisulphide, etc., is not an isolated one. Cannel coal[6] and the Scottish shales are of the same nature, showing slight solubility in certain solvents.

In dealing with the origin of these solid hydrocarbons, experimental and geological evidence would tend to show that their source is practically the same as that of petroleum. Some of the best experimental evidence relating to the formation of these solid hydrocarbons is collected in *Bulletin* 616, issued by the United States Geological Survey, 1916. Some of these data, with original references, are given below.

Engler[7] distilled menhaden oil (fish oil) at temperatures varying from 320 deg. C. to 400 deg. C. and a pressure of 10 atmospheres. He obtained a distillate resembling petroleum, which upon being fractionated gave various type hydrocarbons.

C. W. Day[8] found that upon distilling fish (using fresh herring) a product formed which upon redistillation yielded a residue closely resembling gilsonite. With fish alone the final product was more like elaterite, a natural product closely resembling wurtzilite. Distillation of wood gave a similar residue. Thus natural asphalts were obtained resembling the natural substances and containing nitrogen similar to ordinary asphalt.

A specimen of albertite, an oil shale from New Brunswick, Canada, known as "paper shale," was examined by the writers and found to contain distinct fish remains. This shale was a highly indurated and laminated type, which seemed to be impregnated with bituminous material only along the bedding planes. Adjacent to this was a shale impregnated through and through with the bituminous material, and on whose surface was some pure bituminous material free from kaolinitic matter. The evidence in this particular bituminous substance may be a fish oil residuum.

Ells[9] in describing the oil shales of New Brunswick stated that they are often rich in fish remains. Many other writers cite the presence of fish remains in oil shales, which confirms the animal origin of both solid and liquid hydrocarbons.

This does not exclude the vegetable theory, since vegetable oils[10] likewise yield hydrocarbons upon destructive distillation, and the case of wood has been cited. The nature of liquid and solid hydrocarbons is thus seen to depend on the source, paraffin base oils being thought to be of vegetable origin and asphaltic base oils of animal origin.

OIL SHALES

It has been shown that shales, sandstones and limestones are of sedimentary origin. These rocks grade into one another and shales are found which contain considerable calcite and quartzite either in the original formation or by replacement. All of the rocks are capable of absorbing petroleum, and the resulting rocks are known as oil shales, oil sandstones and oil limestones. Shales which are simply impregnated with oil are not the type which are usually referred to in the literature as oil shales. They are, however, equally entitled to be called oil shales, and, as has been suggested previously, may really be the parent of the present day oil shale deposits.

Rocks referred to as oil shales vary greatly in character. In some types, such as paper shale, the bedding planes are prominent, while in others the laminæ are only developed upon retorting. In some cases the shales are not impregnated with the bituminous material, but the material seems to have simply forced its way along

[2]Maberry, Jour. Ind. Eng. Chem. 6, 101, 1914.
[3]Bacon & Hamor, American Petroleum Industry.
[4]Jour. Chem. Ind. 17, 13, 1898.
[5]Jour. Ind. Eng. Chem., Dec., 1913.
[6]Craig: Jour. Inst. Pet. Tech., June, 1916.

[7]Engler Berichte, 21, 1816, 1888.
[8]W. C. Day, Amer. Chem. Journal, 21, 478, 1899.
[9]Geol. Survey Report Dept. of Mines, Canada, 1909.
[10]S. P. Sadtler, Proc. Am. Phil. Soc. 36, 93, 1897

the bedding planes. Gilsonite occurs in this manner, and albertite in some cases.

In a number of instances the oil and bituminous material contained in oil shales may be dissolved out by carbon bisulphide, benzol and similar solvents. The Scottish shales are, however, not of this character, and wurtzilite,[11] which has been found to be identical with the oil shales of the Green River formation in Western United States, has been shown to be only slightly soluble.

All of these types produce oil upon heat treatment, but[12] those which are insoluble have been classified as containing an oil producing substance which is neither bitumen, petroleum or resin. Crum Brown first employed the term kerogen to denote this substance. A kerogen shale is a shale containing kerogen as distinguished from one containing crude petroleum or bitumen.

Microscopic[13] examination of Autun boghead coals and New South Wales torbanite has shown the presence of irregular shaped yellow bodies, not disturbing the lamination, but sometimes extending across it. It was concluded that these bodies were introduced from some outside source, although Renault and Bertrand[14] looked upon them as being originally derived from a gelatinous algæ, and formed in situ.

Some of the "blaes"[15] (Scottish shales producing very little oil) are carboniferous, but on examination are found not to contain kerogen. In general it has been found that the amount of oil produced from this type of shale is proportional to the amount of these yellow bodies, called kerogen. Thus kerogen seems to be present in only the shales found in anticlinal regions. Examination of a section of this oil shale under the microscope brought out its fine grained and laminated character. The darker shales are more opaque than the lighter, and are consequently harder to examine. Varying quantities of vegetable debris are also present, the darker specimens usually containing more than light colored specimens.

Distribution and Mode of Occurrence

Oil shale occurs in economic deposits in the United States, Canada, Nova Scotia, Scotland, France, New South Wales, Australia, New Zealand, Tasmania, Spain, Austria Hungary, Turkey, South Africa, Brazil and Italy. The most important deposits are in the United States, Canada, Scotland and France.

The Scotch shales as described by Ells[16] are of a chocolate brown color and soft, being easily cut with a knife. They are free from gritty matter. They vary in oil content as well as in ammonium sulphate in different bands, and even in parts of the same bed. The shales approximate what is known as paper shales, and the beds vary in thickness from a few inches to 15 ft., being interstratified with blue-grey portions and hard calcareous or siliceous bands. In[17] area the shale beds cover an extreme length of about 24 miles.

Scotch shales used for oil are known by the terms "plain" and "curly." These are associated with a less rich portion known under the name of "blaes." The curly shale is the more valuable, a larger percentage of hydrocarbons making it softer and more crumbly and easier to mine. "Blaes" on weathering pass into muds. Rich shale, however, remains unchanged by exposure to weather conditions even for years.

The strata are often thrown into folds which bring different portions to the surface at various points. Most of the mining is underground, however, and some of the Scotch workings have been worked to a depth of 1000 ft., the mining being carried on after the fashion of mining bituminous coal. Roofs are supported with timber, props and pillars. A regular system of roads, driveways and drifts has been installed.

The oil shales of New Brunswick[18] are the most important of the Canadian oil shales. The Scotch shales are more papery than the New Brunswick shales, the shaly character of the latter being developed on retorting. The New Brunswick shales burn easily, only the large per cent of ash making it unfit for economic use at present. The types corresponding to the "curly," "plain" and "blaes" of Scotland are found in New Brunswick.

The oil shales of New Brunswick vary greatly in character, ranging from a thin bedded brownish or blackish grey, sometimes quite flexible and elastic, and usually known locally as paper shales, to massive bands of black, tough shales which occur as interstratified beds in the formation as a whole. While the greater part of these shales are bituminous the black massive beds which range in thickness from 3 to 7 ft. are much richer in ammonia, gas and crude oil than the great mass of thinner shales. The sands above these shales have been known to contain small quantities of oil, but as far as is known the oil shales do not contain any. The darker shales have an abundance of plant and fish remains.

The principal economic deposits of oil shale in the United States[19] lie in the Green River formation in Colorado, Utah and Wyoming. There are deposits also in the Eastern[20] part of the United States, underlying the coal fields, cropping out in Alabama, Indiana, Pennsylvania, Tennessee, Virginia, Ohio, Kentucky and Illinois.

Winchester[21] has made an exhaustive examination of the Green River formation, and has made an extensive report on the Western oil shales. The Green River formation has a maximum thickness of 2,600 ft., the middle part of the formation containing the beds most rich in oil-producing shales. This formation consists principally of shale, but contains beds of sandstone, with oolite being present in some parts.

In Colorado the shale area includes probably twenty townships, being 50 miles long and 20 miles wide. In Utah the area may be even greater. As has been mentioned before, the government has reserved 3,692,036 acres of land in this area as oil land for the use of the navy.

These shales are for the most part insoluble in carbon bisulphide, benzol and similar solvents, and have been said to approximate wurtzilite in composition. The mineral matter in which the oil producing substance is held is a smooth non-siliceous clay containing a small amount of carbonate of lime.

[11] De Beque Eng. & Min. Jour., Dec. 9, 1916.
[12] Craig, Jour. Inst. Pet. Tech., June, 1916.
[13] Ibid.
[14] Compt. Rend. 117, 593, 1893.
[15] Craig, Loc. Cit.
[16] R. W. Ells, Canada, Dept. of Mines, 1908.
[17] De Beque, Eng. & Min. Journal, May, 1915.
[18] Report Dept. of Mines, Canada, 1909.
[19] Winchester Bulletin 641, U. S. Geol. Survey, 1916.
[20] Ashley, Bulletin 641, L., 1917.
[21] Bulletin 641, U. S. Geol. Survey.

In Colorado[22] it is estimated that the shale deposits are capable of yielding 20,000,000,000 barrels of crude oil, giving upon refining 2,000,000,000 barrels of gasoline, and those of Utah will probably produce an equal amount. The Colorado shale will probably also produce about 300,000,000 tons of ammonium sulphate, a substance useful as fertilizer and for the production of nitric acid for use in explosives. At many places in Colorado and Utah the rich shale has only a light overburden, and could be mined with a steam shovel, in this respect possessing a great advantage over the method of mining in Scotland and France. But there are particularly tough layers of shale which wear out steam-shovel teeth rapidly, even those of manganese steel, which will be an important factor in the cost of mining. However, in Scotland some pits and shafts are 1000 ft. deep, which factor is not present in the Colorado and Utah deposits.

The principal deposits of shale in France are in Autun and Buxieres. The former has been regularly exploited since 1862 and the latter since 1858. The oil shales in these two principal sections of France occur for the most part interstratified with calcite and quartz strata; the shale being approximately two meters in thickness. The Autun deposits cover about 18,000 hectares (36,000 acres), the mining of which is underground. The oil shale runs fairly uniform in the formation of oil and by-products.

Method of Production and Products

The distilling of oil shales has been known as early as 1694, when Eele, Hancock and Portlock made "oyle from a kind of stone" in England. The details of retorting practice in the various countries have been very well written up by the following experimenters. The French oil shale industry has been balanced against the practice in vogue in Scotland with statistics of production by Chosson,[23] Chesneau[24] and Aron.[25] The industry in New South Wales, Queensland, has been written up in the report of Atkinson[26] and Ball,[27] with statistics for New South Wales from 1865 to 1914. The methods of retorting oil shale past and existent at the present time, with statistics, yields of products in Scotland and Canada, have been covered in detail by Ells,[28] Baskerville,[29] Redwood,[30] Bacon and Hamor.[31]

Outline of Scotch Practice

The following is the merest outline of oil-shale practice in Scottish use to-day. For greater detail the reader is referred to the above references. An oil-shale plant consists in the main of shale-breaking machines, retorts, condensers, ammonia and oil scrubber, fire and steam stills, acid agitators, filters for lubricants and wax, sweat pans, refrigerating house for wax and low cold test lubricants, receiving tanks, gas tanks (or burning the gas made directly under retorts), ammonium sulphate house, boiler house, pump house and laboratory.

[22]Bulletin 641, U. S. Geol. Survey.
[23]Annuales des Mines, 6th series, 20, 347, 1871.
[24]Annuales des Mines, 9th series, 3, 617, 1893.
[25]Annuales des Mines, 10th series, 9, 47, 1906.
[26]New South Wales, Dept. Mines Ann. Report, 1897-1910, 1898 to 1914.
[27]Queensland Govt. Min. Jour. 16, 608, 1915.
[28]Canada Dept. of Mines, Summary Report, 1908, 1909.
[29]Canada Dept. of Mines, Summary Report, 1909. Royal Soc. Canada Trans. 3rd series, 3, 35, 1909. Nova Scotia Min. Soc. Jour., 15, 29, 1910. Eng. and Min. Jour., 88, 149, 195, 1909. Cong. Inter. Chim. App. Comp. rend., 4, 22, 1910.
[30]Redwood, Treatise on Petroleum, 2, 83, 1913.
[31]The American Petroleum Industry, 2, 807, 1916.

The oil shale in small pieces is passed by means of hutches into iron retorts varying in capacity from one-half to two tons per twenty-four-hour day. A number of types of retorts are in use, varying considerably, some keeping the mass of shale in continuous movement; others simply heating the mass, and dumping the charge when no further gases pass over to the condensers. The temperature of retorting varies, dependent upon the type of shale used, from 400 deg. C. to 700 deg. C. The temperature control is highly important, for upon this factor depends the type of hydrocarbons formed and amount of ammonia, the latter forming in greater quantity when steam is passed into the system toward the end of the reaction. The products resulting from retorting the oil shale pass through air or water-cooled condensers and the uncondensed gases are drawn into exhausters. From the exhausters the uncondensed gas is led through water and oil scrubbers to remove ammonia and light hydrocarbons. The scrubbed gas may be used directly for fuel with a "booster" attached or may be passed to a storage gas tank. The ammonia liquor is distilled and the gas passes through sulphuric acid forming ammonium sulphate crystals which are purified for market or sold dry without purification, dependent upon the use.

The usual commercial products resulting from the retorting of oil shale are crude oil, motor fuel, naphtha, burning oil or kerosene, gas or fuel oil, lubricating oils, paraffin wax, still grease, coke and ammonium sulphate. Table III gives the products and yields for the year 1916 of 3,500,000 tons of oil shale retorted in Scotland.

Table III—Scottish Shale Retorted and Products Marketed in 1916 from 3,500,000 Tons Oil Shale

	Gallons	Per Cent Basis Oil Recovered	Approximate	
			Specific Gravity	Beaumé Gravity
Amount crude oil recovered	80,500,000	......	0.91	23.8
Motor spirit	600,000	0.7	0.74	59.2
Naphtha	4,840,000	5.1	0.78	49.5
Burning oil	22,000,000	28.5	0.82	40.7
Gas or fuel oil	13,000,000	16.2	0.86	32.8
Lubricating oil	11,000,000	13.7	0.90	25.5
Paraffin wax (tons)	27,500	1.0	110°-132°	.....
Coke	84,000	3.0	.....	.....
		Basis Ton Oil Shale Used		
Ammonium sulphate (tons)	59,400	1.41	.....	.....
As ammonia (tons)	16,000	0.44	.....	.....

The average cost per ton of oil-shale mining and retorting was \$2.00, and the net profit per ton oil shale retorted \$0.85. In the year 1916, 23 gal. of oil and 38 lb. of ammonium sulphate as an average were produced for each ton oil shale retorted.

The Comparative Yields of Oil and Ammonium Sulphate from Retorted Oil Shale

The vital figures in oil-shale mining are those which will give average gallons of oil and pounds of ammonium sulphate per ton of oil shale retorted. For upon the yields of these two products depends the question whether a plant will be remunerative financially. Winchester[32] in his important contribution to oil shale information has shown that of 132 samples retorted the yields of oil per ton of shale ranged from 0.31 to 90 gal., and the pounds of ammonium sulphate from 0.4 to 12.69 dry retorted. He has worked out a con-

[32]U. S. Geol. Survey, Bulletin 641, 1917.

version factor when the shale is steam-distilled for ammonia which brings the ammonium sulphate values from one to thirty-two pounds per ton shale retorted.

In Table IV the writers have computed the average of fifty-one samples retorted Colorado shale, which gave an oil gallonage of 16.2. Of the fifty-one samples twenty-nine were tested for ammonium sulphate with an average of 7.6 lb. per ton of shale. For the state of Utah the average of thirty-eight samples under similar conditions gave 25 gal. of oil and 5.3 lb. of ammonium sulphate per ton. Wyoming gave 16.4 gal. oil and 6 lb. of ammonium sulphate per ton as an average of forty-two samples retorted. The oil shales of Utah indicate a 40 per cent greater yield of oil per ton than the states of Colorado and Wyoming. Twenty samples of the Colorado shales were tested for the cubic feet of gas per ton of shale retorted, and the average was found to be 2705.

The distillation analysis of nine samples of shale oil from divergent geographic locations have been averaged. The gasoline cut percentages ranged from 6 to 12; the kerosene cut from 28.5 to 49 and paraffin from 1.63 to 7.70, while the unsaturated hydrocarbon in the kerosene cut ranges from 55 to 71 per cent. Although an average over the samples of 9.6 per cent with a Beaumé gravity of 47.9 for the gasoline cut is noted, this is quite different from having 9.6 per cent of an oil which will be suitable for internal combustion engines. It is highly questionable whether in refining and redistilling the above gasoline cut into a motor fuel suitable for internal combustion engines that anything like 9.6 per cent of marketable motor fuel would be obtained from 100 gal. of oil shale as typified by the samples analyzed. The Scottish oil-shale industry for 1916 marketed 600,000 gal. of motor fuel of 59.2 Beaume gravity, which was 0.7 per cent of 80,500,000 gal. of shale oil produced.

TABLE IV—THE AVERAGE GALLONS OF OIL, POUNDS OF AMMONIUM SULPHATE AND CUBIC FEET OF GAS PER TON OF OIL SHALE RETORTED FROM UTAH, COLORADO AND WYOMING[33]

Source of Oil Shale	Number of Samples	Average Gallons Oil per Ton Shale	Average Pounds Ammonium Sulphate per Ton Shale	Average Cu. Ft. Gas per Ton Shale	Specific Gravity Oil	Beaumé Gravity Oil
Colorado	51	16.2	{29 samples 7.6}	{20 samples 2705}	0.9032	25.0
Utah	38	25.0	5.3	......	0.9026	25.1
Wyoming	42	16.4	6.0	....	0.8997	25.6
Average of all samples	131	19.2	6.8	......	0.9018	25.2

AVERAGE DISTILLATION ANALYSIS NINE SAMPLES

	Per Cent	Specific Gravity	Beaumé Gravity
To 150 deg. C. (gasoline cut)	9.6	0.7871	47.9
150 to 300 deg. C. (kerosene cut)	37.3	0.8601	32.8
Asphalt	2.0	......	....
Paraffin	4.9	......	....
Sulphur	0.8	......	....
Nitrogen	1.68	......	....
Unsaturates in (kerosene cut)	61.5	......	....

G. H. Ashley[34] of the Geological Survey has reported upon the black shale of Eastern United States. The lowest yields were noted in West Virginia of 1.4 gal. oil and the maximum of 27.6 for the state of Pennsylvania per ton black oil shale retorted. The latter figure compares more than favorably with the average of Utah and gives a 42 per cent higher oil yield than the states of Colorado and Wyoming.

[33]U. S. Geol. Survey, Bulletin 641, 1917.
[34]Geol. Survey, Bulletin 641, L, 1917.

The data are compiled in Table V.

At least three important factors enter into the profitable mining of black oil shale:

1. Where the out croppings permit of steam shovel use at a minimum of cost.
2. Where the coal is overlaid with oil shale which can be mined at the same time.
3. Where oil shale must be removed to mine the coal and can be retorted at same time.

Ashley has stated that the total area of southeastern Indiana is underlain with shale bearing oil, which contains 100,000,000,000 barrels of oil.

TABLE V—THE AVERAGE GALLONS OF OIL PER TON OF BLACK SHALE RETORTED FROM THE EASTERN PART OF THE UNITED STATES[35]

Source of Oil Shale	Number of Samples	Average Gallons Oil per Ton
New Albany, Ind., Boonville, Ind	7	10.0
Springfield, Ill., Gallatin, Ill	2	14.0
Crittenden, Ky., Louisville, Ky., Caseyville, Ky	3	5.1
Glen Mary, Ohio; Columbus, Ohio; Gahama, Ohio	4	7.1
Cannelton, Pa., Clay Township, Pa., Queen Junction, Pa., Butler, Pa., Zelienople Quadrangle, Pa	7	27.6
Cumberland Gap, Tenn., Rockwood, Tenn., Bakers Station, Tenn., Newson, Tenn., Newcomb, Tenn.	13	5.2
Hancock Station, W. Va	5	1.4
The average of all black shales retorted	....	12.5

The oil shale investigation of Canada has been covered by Dr. R. W. Ells of the Department of Mines, Canada, in a thorough manner. These show a much higher yield of oil and ammonium sulphate than those investigated in the United States. The average yield of oil for forty-four samples for Canada is 34.9, while an average of 131 samples in the United States gave 19.2 gal. per ton. The yield of ammonium sulphate for Canada gave 51.3 lb. and 16 lb. for the United States. Table VI tabulates the data in detail.

TABLE VI—THE GALLONS OF OIL AND POUNDS OF AMMONIUM SULPHATE PER TON SHALE RETORTED. EASTERN CANADA[36]

Source of Oil Shale	Number of Samples	Imperial Gallons per Ton	U. S. Gal. per Ton	Specific Gravity	Pounds Ammonium Sulphate per Ton
Albert Mines	5	40.6	48.7	0.893	59.4
Frederick Brook	4	31.4	37.7	0.890	40.4
Dover	4	27.4	32.9	0.921	29.5
Taylorville	7	44.2	53.0	0.905	95.9
Baltimore	4	49.9	59.9	0.893	71.1
Prosser Brook	1	30.0	36.0	0.895	75.0
Goshen	1	27.5	33.0	0.897	36.0
Maple and Elgin	2	7.0	8.4	0.891	(a)
McLellan Brook	9	15.9	19.1	0.897	30.2
Antigonist	4	13.5	16.2	0.901	27.9
Gaspe Quebec	3	32.2	38.6	0.948	47.3
Average of all samples	44	29.1	34.9	0.903	51.3

(a) Not determined.

Since cannel coal is analogous to some extent to oil shale, for comparative purposes some work by Ashley[37] and Ingram[38] on cannel coal has been given, the data of which are shown in Table VII. An average of thirteen samples gave 38.8 gal. of oil, which is 100 per cent higher than the average yield of Utah, Colorado and

[35]Geol. Survey, Bulletin 641, L, 1917.
[36]R. W. Ells, Geol. Sur. Branch Dept. Mines, Canada, Vol. 26, 200, 1909.
[37]U. S. Geol. Sur., Bulletin 641, L., 1917.
[38]Bulletin School of Mines, University of Missouri, 1917.

Wyoming. This oil from distillation analysis compares favorably with the oil from shale. The geological data as to the size and extent of cannel coal deposits in the United States are not obtainable to any extent. In the Caney Creek[39] region of Kentucky there is a workable section of cannel coal of 2000 acres. The writers have calculated that this area would produce approximately 10,000,000 barrels of oil and 11,000,000,000 cu. ft. of gas.

TABLE VII—THE AVERAGE GALLONS OF OIL, POUNDS OF AMMONIUM SULPHATE AND CUBIC FEET OF GAS PER TON OF CANNEL COAL RETORTED FROM PENNSYLVANIA, MISSOURI AND ILLINOIS

Source of Cannel C al	Number of Samples	Average Gals. of Oil per Ton	Specific Gravity	Cu. Ft. Gas per Ton	Beaumé Gravity	Pounds Ammonium Sulphate
Indiana Co., Pa.; Armstrong Co., Pa.; Annelton, Pa.[1]	5	29.6	.....	4885	....	17.2
Wainwright, Mo.; Princeton, Mo.[2]	6	51.4	0.914	7193	23.2	(a)
Herrin, Ill.[2]	2	34.6	0.912	4440	23.5	(a)
Average of all samples	13	38.8	0.913	5506	23.4	.....

(a) Not determined.
(a) Not recorded.
[1]Ashley U. S. Geological Survey Bulletin, 641 L., 1917.
[2]Ingram Bulletin School of Mines University of Missouri, 1917.

The oil-shale industry in France began in 1830 with a commercial process perfected by Selligue in 1839. The industry flourished until 1864 when it received a shock similar to Scotland, due to the introduction of American petroleum in 1864. American and Russian refined petroleum products practically paralyzed the oil-shale industry from which it took a long time to recover. The oil-shale retorting practice of France was for many years in oil productivity much lower than Scottish practice. The French practice was to retort at a relatively low temperature, no steam being used during cracking for increasing the yield of ammonia. It was not until 1903 that the Young and Fyfe retorting method was installed in French practice. The advantages of this method over the older one were that it allowed of a saving of fuel and increased the ammonia and oil yield. In Table VIII the gallons of oil per ton of oil shale retorted over a period of years is given. The immediate effect of the Young and Fyfe method of retorting is shown clearly in the year from 1903 to 1904, where the oil yield jumped from 18.1 to 20.7 gal. of oil per ton of shale.

Aron[40] states that by the introduction of steam and higher temperatures in oil-shale retorting practice in France a saving of 80 centimes per hectolitre of oil was accomplished. In the Autun and Allier districts in 1893 there were 96 plants in operation with 414 French retorts and no Scotch; while in 1905 of the 74 plants in operation there were 232 Scottish retorts and only 60 French. It is more than likely that at the present time Scottish retorting is in vogue in all plants in France.

The production over a series of years as shown in Table VIII gives a steady increase in gallonage of oil per ton of shale retorted due to improved methods of retorting. But, the amount of oil produced per year is negligible in comparison to the oil requirements of France and also shows a decline in oil shale retorted. Edouard[41] in 1915 stated that "France, which does not produce petroleum at all, is obliged to get from foreign countries all she consumes." In the *Annales des Mines* for the latter years no statistics of oil shale or products resulting therefrom are given. Beranger[42] in July, 1917, proposes that France coke coal for the production of gas and oil, the latter to be used for the industries and fuel for ships. He emphasizes the utter dependence of France in peace as well as war times upon foreign countries for petroleum products and advises the government to seek oil production in Persia and other countries so as to preserve the economic life of France. The needs of France in this respect are 30,000 tons of gasoline for the army and 20,000 tons for the interior per month. This amounts to 225,000,000 gal. of gasoline a year as the needs of France. The total oil produced from shale was in round numbers 3,700,000 gal., of which probably 2 per cent was gasoline or 74,000 gal. of gasoline, which is practically a negligible quantity in comparison to the 225,000,000 gal. gasoline required yearly in France.

TABLE VIII—TONS AND OIL PRODUCTS FROM FRENCH SHALE

Year	Shale Retorted (in Tons)	Oil Produced (Hectolitres)	U. S. Gallons	U. S. Gallons per Ton
1893	186,040	97,820	2,584,111	13.9
1894	185,617	94,457	2,495,271	13.6
1895	216,079	106,958	2,825,410	13.1
1896	178,574	100,415	2,652,795	14.9
1897	190,302	114,763	3,031,694	15.9
1898	181,988	109,963	2,904,892	16.5
1899	209,125	131,865	3,483,478	16.7
1900	220,609	134,191	3,544,923	16.1
1901	208,070	131,612	3,476,794	16.7
1902	212,955	141,821	3,746,459	17.6
1903	198,280	136,136	3,596,304	18.1
1904	184,030	139,826	3,693,783	20.7

The oil shale industry in New South Wales[43] is approximately sixty years old. The method of retorting is the Scotch one, which up to the present is the most successful in use. The industry in New South Wales has declined markedly in the last twenty years, dropping from 59,426 tons in 1895 to 17,425 tons oil shale retorted in 1916. The amount of oil produced per ton of shale retorted was not obtainable, but on the assumption of 20 gal. of oil per ton of shale, 348,500 gal. of oil would be produced. The data in Table VIII-A expresses the tons of oil shale retorted from 1865 to 1916 and the value per ton in pounds sterling.

TABLE VIIIA—TONS OF SHALE RETORTED IN NEW SOUTH WALES, YEAR 1865-1916

Year	Quantity, Tons	Total Value in Pounds Sterling
1865	570	2,350
1875	6,197	15,500
1885	27,426	67,239
1895	59,426	75,218
1905	38,226	21,246
1915	15,474	12,890
1916	17,425	17,772

Independence, Kas.

Chihuahua Smelter Re-opens.—The American Smelting and Refining Co., reopened its smelter near Chihuahua, Mexico, on March 31st, after a shut-down lasting since November 1915. About fifteen Americans and 500 Mexicans are at work, which number will be doubled shortly if conditions seem to warrant the step. The Americans are housed in Chihuahua City, and taken to and from work in automobiles.

[39]Kentucky Geological Survey, Bulletin, 10.
[40]Annales des Mines, 10th series, 9, 47, 1906.
[41]L' E'conomiste Francois, Paris, July, 1915. Vol. 2, p. 3, "Le Petrole La Production," etc.
[42]L'Echo des Mines, 1917.
[43]New South Wales Mines Dept. Annual Reports, 1914-1916.

A Process for Deodorizing Fatty Oils

BY WALTER P. SCHUCK*

IN THE preparation of vegetable and animal fats and oils for commercial use a large portion of these substances is treated by some deodorizing process in the course of refining. According to Lewkowitsch,[1] one of the earliest methods of deodorizing oils was by heating them to a high temperature. This method will destroy the characteristic odor of many oils if the temperature employed is high enough. Many recent attempts have been made to apply this method to the deodorization of fish oil on a commercial scale in Europe. While the characteristic odor of an oil may be destroyed by heating, a more or less burnt or other unnatural odor is usually developed and therefore the method has not been used for the preparation of edible oils.

The process commonly used to deodorize an oil without changing any of its properties except odor and taste, consists in blowing live or superheated steam through the oil for a sufficient length of time to secure the desired result. This process is effective only on those oils whose odor and taste are due to the presence of small quantities of substances that might be classed as impurities and are carried away by the steam. That is to say, if oils are considered as essentially mixtures of the glycerides of fatty acids, the steam-deodorizing process is effective only when the characteristic odor is not due to one of the constituent glycerides. Fortunately the steam-deodorizing process has made it possible to obtain odorless and pleasant tasting oils from nearly all vegetable oils that were desired for edible purposes. Fish and marine animal oils, however, cannot be completely and permanently deodorized with steam.

Despite the wide application of the steam-deodorizing process it is well known that the conditions to which this process subjects the oil are such as to promote decomposition. The action of hot water or steam has been used to hydrolyze fatty oils into glycerine and fatty acids, high pressure being advantageous in the process. This pressure is not present when deodorizing with steam. The contact of steam and oil at a high temperature does exist and tends to set free the fatty acids. This does not cause the oil to take on a rancid taste or smell immediately; it does tend to develop rancidity later.

About two years ago while the author was carrying on some experiments on the catalytic hydrogenation of naphtha-extracted corn oil, he observed that a sample which had not been purified sufficiently to allow the catalyzer to act and which had not hardened, nevertheless was rendered odorless and palatable by the action of the hydrogen on the oil containing a catalyzer in suspension. Although no appreciable hardening had taken place, the improvement in odor and taste was so marked that a fresh sample was treated under identical conditions except that no catalyzer was present. This sample proved to be equal in odor and taste to that treated with hydrogen in the presence of a catalyzer and thus showed that the catalyzer did not function in the removal of odor from the corn oil.

Knowing that fish oils had not been deodorized unless they were at least partially hydrogenated in the presence of a catalyzer, the treatment with hydrogen only was next tried on a fish oil. After several attempts the proper conditions were ascertained and a sample of fish oil was produced that was odorless and palatable.

The method of deodorizing any oil or fat by this process consists of blowing hydrogen, or a gas whose principle constituent is hydrogen, through the heated oil and allowing the hydrogen with the entrained vapors from the oil to escape freely from the containing vessel until the desired result is obtained. In the commercial application of this process, the fatty acids and other fumes are condensed and washed from the hydrogen which is thus completely purified and used over again. The entire apparatus should, of course, be filled with hydrogen to the exclusion of all oxygen from the air at the time of its first use. Thereafter each new batch of oil is introduced and the deodorized oil withdrawn through pipes so that no air enters the apparatus. A means of drying the hydrogen is provided in the gas-purifying system if the oil being treated contains appreciable quantities of water.

CHEMICAL AND PHYSICAL MEANS USED

The means whereby the deodorization is accomplished in this process are both chemical and physical. The iodine value of the oil treated is lowered to a certain extent and the amount of lowering is proportional to the original iodine value. The process can be successfully operated when the oil comes in contact with nothing but glass and hydrogen during treatment. As far as I have been able to ascertain, glass cannot act as a catalyzer and assist the chemical union of hydrogen with the glycerides of unsaturated fatty acids. Nevertheless I have conducted numerous tests in which an oil was subjected to the action of a stream of hydrogen in a glass distilling flask and have found that the oil so treated is more nearly saturated with respect to hydrogen than the untreated oil as is shown by the lowering of the iodine value. This would indicate that a small but effective portion of the hydrogen actually combines with the oil. This was suspected from the fact that fish oils treated by this process are as effectively and permanently deodorized as they are when subjected to catalytic hydrogenation. A trace of the oil and practically all of the free fatty acids contained in it are mechanically carried away from the oil during treatment. Hence the assumption would not be justified that hydrogen is actually combined with the oil just because the iodine value is lowered. The iodine value might be lowered also if the material carried away was of a more highly unsaturated character than the untreated oil.

To determine more accurately what takes place during

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[1]Volume 3, page 19.

this process, a number of experiments were carried on in which two samples of each oil were subjected to the action of a stream of pure hydrogen and pure nitrogen, respectively, under identical conditions. The fumes carried away from the oil were condensed from the gas and at the end of the experiment practically the entire weight of the oil subjected to treatment was accounted for in the weight of oil remaining in the flask plus the weight of condensate. The iodine values of the remaining oil and of the condensate were determined in each case. It was thus found that in every comparative test the total iodine absorptive capacity of the remaining oil plus condensate was less when hydrogen had been used than when nitrogen had been used. In other words, the iodine value of the total oil body in contact with hydrogen was in every case lower than the iodine value of the oil body in contact with nitrogen, although no metal that might have acted as a catalyzer was present. It would seem from these experiments that my deodorized oil so closely resembles an oil deodorized by catalytic hydrogenation because the two processes are essentially the same; that is, the deodorization taking place in this process is at least partly due to hydrogenation. It has been claimed by Tsujimoto[3] that the odor of fish oils is due to the glyceride of clupanodonic acid which has four unsaturated carbon atoms. As this is only a minor constituent of the oil and since the introduction of hydrogen at only one double bond would change it to a different and probably inodorous compound, it is easy to comprehend how a slight addition of hydrogen to fish oil can make it permanently inodorous.

In the comparative tests above described it was found that nitrogen left the oils with a burnt taste and in some cases with only part of the characteristic odor removed. The free fatty acids remaining in the nitrogen-treated oils is about three times as much as in the hydrogen-treated oils.

An interesting and valuable feature of this process is the rapidity with which free fatty acids are removed from the oil by the stream of hydrogen bubbling through it. These fatty acids begin to pass from the oil at about 240 deg. C. and can be removed from most oils to within 0.15 per cent in 20 min. at 275 deg. C. Cocoanut oil containing over 14 per cent free fatty acids has been purified by this process to a free fatty acid content of 0.12 per cent. A fish oil containing 5.14 per cent f.f.a. was purified by this process so that it contained only 0.14 per cent f.f.a. and the total shrinkage during the hydrogen treatment was only 6.10 per cent. The removal of free fatty acids took place during deodorization. It will be seen that the loss in purifying was only 1.10 per cent more than the loss due to actual removal of free fatty acids. The free fatty acids so removed are condensed from the current of hydrogen and recovered uncombined so that soap can be made from them by neutralizing with soda ash.

In regard to the keeping qualities of oils and fats treated by this process it can be stated that oils so treated stay sweet very much longer than steam-deodorized oils. An exact comparison cannot be made because the oldest samples (treated 21 months ago) are still free from rancidity. A sample of cocoanut oil was treated by this process at the same time that some of the same oil was deodorized with superheated steam in a factory. Both samples were put in clean tins with lids loosely laid on, then alternately kept in a warm place where the oil was liquid during the day and in a cool place at night for four months. The steam-deodorized oil became rancid in a few weeks and was very poor in quality in two months. The hydrogen-deodorized oil was pleasant to taste after four months' storage under the described conditions and is still so. The keeping qualities of hydrogenated oils are well known and since the keeping qualities of oils deodorized by this process are due to the action of the hydrogen, it is not surprising that they should be stabilized and rendered free from the tendency to become rancid.

[3]Journ. Coll. Eng. Tokyo Imp. Univ., 1908—177.

Commercial Possibilities

Among the commercial possibilities of this process the purifying of fish oils so as to render them edible is of prime importance. Even the deodorization of fish oils for technical purposes is a matter of interest. The fish oils deodorized by this process cannot be made to smell of fish by subjecting them to heat or any other action that oils are usually subjected to. While this process cannot take the place of catalytic hydrogenation of fish oils in every case because the oil is not hardened, it is very much cheaper to operate. Fish stearine which is naturally a solid fat at ordinary temperatures can be made into an acceptable cooking fat at very low cost by this process.

Fats which have been burnt from continued use in cooking and have absorbed the odor of fish, onions, garlic, etc., can be rendered perfectly bland and neutral by this deodorizing process. Likewise garbage- and rendering-works grease can be purified so that it is neutral and free from objectionable odor. This latter class of fats usually contain substances that "poison" a catalyzer and therefore are not easily deodorized by catalytic hydrogenation. Since this process does not involve the use of a catalyzer such substances do not interfere.

In the treatment of castor oil this process is of value for two purposes. The medicinal castor oil can be rendered entirely free from its characteristic odor and taste while still retaining its medicinal properties. The lower grades which have a high free fatty acid content can be treated for the reduction of the free fatty acid content and thus render them more acceptable for the lubrication of machinery.

Certain vegetable oils such as soya bean oil are not readily deodorized with steam but are rendered bland and palatable by this process.

It is not to be supposed that every crude fatty oil can be treated by this process just as it is found in commerce nor that low grade greases can be made into light colored, clean fats without more shrinkage than the removal of the free fatty acids would entail. The solid matter, such as particles of cellular tissue, should first be removed by clarification and filtering in order to get the lightest colored product. The total shrinkage will therefore depend on the amount of impurities present and the commercial possibilities can only be determined by a study of the oil or fat under consideration.

The use of the process here described is protected by U. S. Patent No. 1260072 as well as other applications for patent on file and by applications for patent on file in foreign countries.

Synopsis of Recent Metallurgical and Chemical Literature

Experimental Carbon Cell

At the recent meeting of the American Electrochemical Society a paper was read by Dr. S. ALBERT REED of New York City. A primary battery was described in which the electrolyte is fused borax containing manganese dioxide, the negative pole is broken carbon in contact with a graphite grid and floating on the melt, while the positive poles are strips of gold foil. The carbon is kept inside a cylindrical shell of siliceous material (a sawed-off crucible), while the melt is contained in a shallow clay roasting dish, in which the cylinder stands. The air oxidizes the electrolyte in contact with the outer gold strips, while the carbon reduces the electrolyte inside. Mixtures of CO_2 and CO are produced at the anode. The voltage averages 0.8.

Analysis of Ferro-Silicon

Another paper at the convention was on the "Commercial Analysis of Ferro-Silicon" by EARL M. ANGER, research chemist of the Chile Exploration Co., New York City. The author said he had read with much interest papers by a number of writers on the commercial analysis of ferro-silicons of various grades. Nearly all gave long, tedious methods, and not all of the necessary accuracy. Some writers determine several elements and then call the balance silicon. There are several elements which often occur in ferrosilicon of these grades when manufactured from iron ore or iron cinders, which are entirely neglected in this calculation. Any one of these elements may at times contaminate ferro-silicon up to 1 per cent. He then gave personal notes and experiences in the commercial analysis of electric furnace ferro-alloys for carbon, manganese, phosphorus, phosphorus evolved as phosphene, sulphur, iron, titanium, calcium, magnesium, aluminium, barium, and silicon; with advice on sampling. Many samples which he examined contained 0.1 to 0.5 per cent barium.

Electric Steel Castings

In a paper on this subject read at the recent meeting of the American Electrochemical Society by R. F. FLINTERMAN, the author said in part:

"During past months we have been experimenting along this line and wish to refer briefly to some wonderful tests we have been getting from vanadium steel. These tests have been obtained repeatedly, so that we are confident that we can reproduce them commercially.

"The tests we refer to are the following:

	No. 1		No. 2	
Ultimate strength..	102,000 lb.	74 kg./sq. mm.	103,800 lb.	74 kg./sq. mm.
Elastic limit.......	81,500 lb.	57 kg./sq. mm.	84,000 lb.	59 kg./sq. mm.
Elongation in 2"....	23 per cent.	....	21 per cent.	....
Reduction in area..	48 per cent.	....	47 per cent.	....

"There is just one more point which I desire to bring to your attention. In the discussion of my paper before this Society in May, Prof. J. W. Richards spoke in part as follows[1]:

" 'Regarding the general question of the fitness of electric furnace steel for steel castings, for the information of the Naval Consulting Board I sent a questionnaire to about forty or fifty of my friends in the steel business, asking how a better class of steel castings could be obtained. About nineteen out of twenty of these answers were that if they would specify electric furnace steel for their castings that, other things being equal, there was a far better chance of getting a fine casting from electric furnace steel than from any other class of steel.'

"This statement of Prof. Richards sounds strangely prophetic, when read at this time in the light of what has happened since these words were spoken. Referring to our own experience, we are furnishing considerable quantities of army castings under Class No. 2 and No. 3 specifications, and are also making navy castings under Class 'B' specifications, and are having little trouble in meeting these specifications.

"We do not want to give the impression that these results are being obtained without any particular effort on our part, for quite the contrary is the fact. The heats are held for analysis before pouring, and every possible effort is made to have carbon and manganese where we desire them, before the heat is poured. Annealing is carefully carried out in new ovens recently installed, and here again every care is taken to see that annealing is exactly what we have planned it to be.

"The result of these precautions is that we are passing army and navy tests regularly. We do not hesitate to say, however, that with the same precautions we would fail on many of the tests were we using converter steel. At least that was our experience when we made converter steel, and it is our belief that many converter foundries are having this same trouble at the present time.

"The tests that we are obtaining are interesting in one way. They rather emphasize the fact that the specifications were not written for electric steel. For instance, Class No. 2 army specifications—

	Call for		We obtain	
Ultimate strength..	75,000 lb.	53 kg./sq. mm.	75,000 lb.	53 kg./sq. mm.
Elastic limit.......	35,000 lb.	25 kg./sq. mm.	40,000 lb.	28 kg./sq. mm.
Elongation in 2 in..	15 per cent.	....	20 per cent.	....
Reduction in area..	20 per cent.	....	30 per cent.	....

"In the same way Class 'B' navy specifications—

	Call for		We obtain	
Ultimate strength..	60,000 lb.	42 kg./sq. mm.	65,000 lb.	46 kg./sq. mm.
Elastic limit.......	27,000 lb.	19 kg./sq. mm.	35,000 lb.	25 kg./sq. mm.
Elongation in 2 in...	22 per cent.	....	30 per cent.	....
Reduction in area..	30 per cent.	....	40 per cent.	....

"In addition to the above, a 120-deg. bend test is required, which usually shows a bend up to 170 deg. or 180 deg.

"This army and navy steel-casting experience is really a great education for many of the steel foundries, and is bound to have a marked influence upon the industry after the war. Instead of a statement of hoped-for qualities, competition will demand physical test coupons, which must stand certain tests, and the casting will be accepted or rejected on the basis of these tests. It is needless to add that castings sold under such an arrangement must necessarily be of a uniformly higher grade than the average run of steel castings now sold."

[1]Trans. Am. Electrochemical Soc., 1917, 31, 80.

Personal

Mr. R. E. PARKS, assistant general manager of the Aluminum Company of America, Maryville, Tenn., has been promoted to the position of general manager of the company's plant at Vadin, N. C.

Mr. JOHN JOSEPH CARTY, Colonel, Signal Corps, U. S. Army, was the recipient of the Edison medal awarded by the American Institute of Electrical Engineers on May 17, 1918.

Mr. GEORGE B. HOGABOOM has been granted a leave of absence by the Scovill Manufacturing Company, in order to accept the appointment as electroplating advisor for the Bureau of Standards. He entered on his new duties May 15.

The following changes are announced in the Department of Chemistry in the College of the City of New York: Assistant Professor F. E. BREITHUT, who has already been granted a leave of absence for the duration of the war, has been commissioned as Captain in the U. S. Army, and has already reported for duty. Dr. B. G. FEINBERG, Tutor in Chemistry, has been appointed Research Chemist in the Ordnance Division of the United States Army, and ordered to report for duty May 17. Mr. D. L. WILLIAMS, Instructor in Chemistry, has been called into the National Service to be in charge of the Division of Supplies of the Research Department of the Gas Warfare Section of the United States Army, to report by June 1 at the latest. Mr. PAUL GROSS, Tutor in Chemistry, has been commissioned as Second Lieutenant in the United States Army, and was required to report for duty in Washington on the morning of May 9.

Mr. H. KENYON BURCH, who has been connected with the Inspiration and Miami Companies at their Arizona concentrators for several years, has been engaged by the Phelps-Dodge Corporation to design and build the 3000-ton concentrator at Bisbee, Arizona, for the Copper Queen Department.

JOHN A. TRAYLOR has resigned from the position of Western Manager of the Traylor Engineering and Manufacturing Company, and will devote his time to his mining interests, with headquarters in Salt Lake City.

ORVILLE R. WHITAKER, who conducted the recent investigation into the smelter schedules in force in Colorado, has been appointed by the Dominion government to be an independent judge on a commission to investigate the new schedules of the Consolidated Mining and Smelting Company of Canada, operating the Trail smelter. The appointment of this commission followed representations from the mining men of British Columbia that the new rates would mean wholesale closing of mines in their province.

Current Market Reports

Non-Ferrous Metal Market

Thursday, May 23—A hearing has been called for at San Francisco by the U. S. Tariff Commission to be held during the week of June 24 to deal with tungsten, quicksilver, antimony and their manufactures.

Antimony.—This metal was in better demand and business of considerable magnitude was done. We quote spot at 12¼@12½c. for the week, with 12½c. at the close.

Chrome.—The Western sellers of this ore have slightly reduced their price and are now more in line with the Eastern market. The latest offers from the West are at $1.50 to $1.55 for 45 per cent Cr_2O_3 f.o.b. shipping point.

Copper.—Prime Lake, Electrolytic and Casting are quoted at $23.50, Government price.

Lead.—There has been no change in the lead market during the last week. The price of 7c. New York is maintained; outsiders are quoting slightly above that figure.

Manganese.—Unchanged at $1.20@1.30 per unit for metallurgical ore, 48 per cent grade.

Molybdenum.—Unchanged at $1.15 per pound for 90 per cent grade.

Spelter.—Prices on spelter are quoted at 7¼c. to 7½c. per pound, New York delivery. The Government has fixed the following maximum prices for zinc, subject to the trade discounts and differentials in effect Feb. 13, 1918: Grade A, 12c.; plate, f.o.b. plant, 14c.; sheet, f.o.b. plant, 15c.

Tin.—In view of the clearer position as to shipments of Banca tin to this country the tin market has eased off a little and the London price has now been reduced to £363 per ton. The spot market is exceedingly firm and prices well in excess of $1.00 have been paid for early deliveries.

Tungsten.—Unchanged at $24.00 for scheelite. Tungsten ore of an inferior grade, though available only in small quantities, changed hands at prices according to quality from $20.00 to $23.00.

OTHER METALS

Aluminum, lb., 98-99 per cent., virgin, Government price	.32
Bismuth, lb	2.50–3.50
Cadmium, lb	1.40–1.50
Nickel, electrolytic, lb	.40
Silver, oz. (official)	.99½
Platinum, oz	105.00
Palladium, oz	135.00
Cobalt, lb	2.50–3.50
Magnesium, lb	2.00
Quicksilver, Cal	125.00
Quicksilver, Mexican	118.00

The Iron and Steel Market

May has easily been the steel industry's banner month in production, production of ingots having been at the rate of about 45,000,000 tons a year. The best record previously was a rate of 44,400,000 tons, last November. Production in January was at a rate below 30,000,000 tons. Production of finished rolled steel is approximately 75 per cent of the production of ingots. Prior to the war the proportion scarcely varied by one per cent, from 76 per cent, taking a year as a whole, but 1916, with its large production of shell steel, involving heavy discards, brought the proportion down to 75 per cent.

While the steel industry usually sees its heaviest production in March and October, the high point was reached later this year, as the railroads were still in poor operating condition in March.

PIG IRON AND SCRAP

There is a curious coincidence in the matter of relative production of pig iron and steel ingots. In 1916, the last year for which complete data are available, the production of pig iron was 39,400,000 tons and the production of ingots 41,400,000 tons, showing 2,000,000 tons more ingots than pig iron. A considerable part of the pig iron produced was used in foundries, while on the other hand the steel-making departments used a great deal of scrap, the one tending to balance the other. While there is a wide divergence between the production of steel ingots and the production of finished rolled steel, for many years the production of finished rolled steel has been almost precisely equal to the production of steel-making pig iron, the use of scrap arising outside the steel works approximately making up the carbon and silicon losses from the weight of pig iron as well as the scale produced and other material lost beyond recovery by the open-hearth steel furnace.

Now in April of this year the production of pig iron was at the rate of about $40,400,000 tons and the production of steel ingots at the rate of about 42,650,000 tons, showing approximately the same divergence as was shown in 1916. The coincidence is fortuitous, however. Undoubtedly much less pig iron is being consumed in foundries this year than was the case in 1916, and it follows that the consumption of scrap has been correspondingly less. This is a reflection of the known market condition that scrap is scarce. There is very little old material being brought out, because there is little wrecking of railroad rolling stock and of old bridges and buildings. It is true that there is much shell steel being produced, but that is a condition that obtained in 1916 also, and presumably of late all discards possibly applicable to the rolling of commercial steel have been so used. The steel has been rolled into light rails, concrete reinforcing bars, bedstead angles and similar forms, being particularly in request on account of the light supply of old rails for rerolling.

With the insistence of the Government upon a maximum diversion of steel to war purposes it is probable that the employment of shell discard steel in these directions will decrease, the material being forced into the open-hearth furnaces even though from the pecuniary standpoint it is more valuable when rolled into merchantable product. Profits cannot be considered in this connection. Were there not this expectation it is doubtful whether the steel-making units could hope to operate at capacity, for the steel ingot capacity in existence is fully 47,000,000 tons, and it may be a couple million tons more, while the blast furnace capacity can hardly be much in excess of 43,000,000 tons.

War Steel

Since early in April, when the Washington authorities began insisting that the steel industry divert every ton of steel to war work that could possibly be used in filling war orders, there has been an increasing diverting of steel in that direction, and a diminution in shipments to ordinary commercial industries, even though the total production has been increasing steadily.

The great question has been how much steel the war items could possibly use. The insistence upon maximum shipments is no criterion, for the reason that as a measure of safety it is desired that the various war activities be stocked up, and an eye is also held on next winter, when there may be a partial recurrence of the distressing blockade of last winter. Shipbuilding, for instance, may be consuming at the present time less than 200,000 tons of steel a month, but a million tons could easily be accumulated to advantage at the scores of fabricating shops that are serving the shipyards making fabricated ships, and at the shipyards with their hundreds of shipways.

For a clearer insight into this matter, and for a more efficient distribution of the steel as produced, there was appointed on May 17 a joint committee of representatives of the Government and of the steel makers, to go into this whole subject. The committee will gather additional information, and will besides view the matter from a somewhat new angle, the question of time as well as tonnage being considered. Hitherto the orders and requirements of the Government have been stated precisely in terms of tons, but quite indefinitely in terms of delivery periods.

In the past few weeks the matter of steel for shipbuilding has been one of shipping the maximum tonnage possible, irrespective of the rate of current consumption. The steel industry has been expecting that sooner or later the shipbuilding industry would become so stocked that a curtailment would be called in the rate of shipping. Whether this will be the case or not, the announcement in the past fortnight of the shipbuilding program for 1919 gives a more specific suggestion as to the prospects as to the rate of consumption than has hitherto been available. The program involves 3,000,000 tons deadweight of wooden vessels, requiring but a modicum of steel, and 12,000,000 tons deadweight of steel vessels, requiring about one gross ton of finished rolled steel for three tons deadweight vessel capacity. Thus, apparently, the contemplated rate, when shipyards are all working, will involve some 350,000 gross tons a month of rolled steel, which may be compared with about 2,800,000 tons a month production at the latest rate. Very nearly all the capacity available for rolling heavy sheared plates will be engaged, but the contribution of other departments will be light. Shell steel requirements may run 200,000 to 400,000 tons a month. The 100,000 freight cars recently ordered will require fully 1,000,000 gross tons of rolled steel, axles and wheels. Fabricated steel requirements will be heavy for months but this demand will hardly continue. For various requirements large tonnages of sheets and other material are called for. In the long run, however, it seems altogether improbable that all direct war activities will consume much more than half the steel produced.

It has become clearer and clearer, however, that there are scarcely any really nonessential industries, normally consuming steel. Nearly all are more or less helpful, indirectly, towards winning the war. Accordingly, the so-called "commercial" steel is to be distributed according to the relative importance of commercial industries. Already steel for oil production and transport and for agricultural pursuits is being given first preference after war and railroad orders.

A very large tonnage of steel is to be sent abroad. General Pershing has made quite a reputation as a borrower, having borrowed from France and Britain steel in various forms which he has called upon the Government to repay, in the sum of about 1,250,000 tons of steel. There is no longer a measure of the steel that leaves the country, as in the familiar statistics of exports there does not appear the cargoes of vessels owned or chartered by the Government. They do not clear in the usual manner, and the steel they carry, no matter who is the consignee, does not appear as exports.

Chemical Market

Coal Tar Products. The demand for crudes has eased off greatly with considerable change made in prices because of the offerings at price concessions. The intermediates continue to be in good demand, with prices generally unchanged, although inclined to be firmer.

Benzol: Prices have undergone changes because of the surplus offerings which have weakened the tone of the market. Consumers are apparently not interested at present and are awaiting further market changes.

Phenol: The demand continues light with much larger supplies of material coming on the market, as producers who have been giving over their entire output to the government are now offering in the open market. Prices have registered declines.

Toluol: There have been releases made to benzoate of soda producers at varying prices. There is a better prospect in view for the spot market as offerings may become more plentiful should the government permit the release of any quantities of surplus toluol.

Naphthalene: The situation continues to be quiet with considerable ease. Offers have been very liberally made and in order to move material price concessions have been made.

Benzoate of Soda: In the face of offerings of larger quantities of material and the releases being made to producers under government sanction the market has eased up. Prices are lower with a restricted demand.

Dimethylaniline: Production continues to be confined to a few producers. Prices are holding firm with a fairly active demand.

Paranitraniline: There are only few sources of production, although the requirements of the market are being met with. Prices are firm and seem to be inclined higher.

Aniline Oil: Business of moderate proportions is passing Prices are slightly easier.

Beta Naphthol: The demand has lightened, although still of fair proportions. There is little change in the sublimed grade, the price of which is quotably unchanged. The technical grade is the more active.

Alpha Naphthylamine: An easier tone is to be noted and prices have gone a little lower. Supplies that are fairly large are available.

Metatolumylenediamine: The demand is active but not heavy. Production has been helped by the releases of toluol.

Para Amido Phenol: Production of ample proportions is being maintained with prices unchanged.

Phthalic Anhydride: The tone shows no change and is firm. Prices are holding at the same levels.

Heavy Chemicals: Not a great deal of important change is noted one way or the other on any of the items that fall under this classification, and for the most part the condition has been comparatively slow, with prices ruling at slightly lower levels than were previously noted for some items. After several days of inactivity, caustic soda was reported slightly improved late at the close, but its neighbor, soda ash, has failed to respond in sympathy, and wide price ranges continue to be heard on account of considerable speculation as to futures. All acids continue in scant supply in the open market.

Caustic Soda: Business in the New York market on this item has been chiefly of a routine character, but factors reported a slight improvement late at the close in view of

a better inquiry from the majority of large consumers. On spot prices ranged from \$4.25 to \$4.50, but perhaps on firm bids even these figures could be shaded because there are apparently sufficient supplies on hand to take care of a better consumer demand. Not a great deal of additional interest is being displayed on forward positions and prices are quotably unchanged on contracts for over the year in the neighborhood of 4.60 works. For 1919 business from 3¼c. works is the figures most generally heard for the 60 per cent, but little business is noted for this position.

Soda Ash: This item continues to be neglected by the majority of users, and prices continue at lower levels than have been named for a long time. For stocks in bags prices for spot were practically at unchanged levels of a week ago of 2.15 store. Ash in barrels is of little interest at this writing to consumers and closing figures were at 2.60 and up to 2.70, according to quantity. Little underlying strength is noted on account of comparatively light inquiries.

Acetic Acid: For the most part all acetic acid is nominal on account of large requirements from the Government for this material. Little, therefore, is reaching the open market and sales that have been recorded have passed at higher levels than have been noted for some time. The demand is heavy from all directions and the principal accomplishment in practically any degree of this product is that of locating supplies. During the interval sales have been recorded on the 28 per cent material as high as 16¼c., barrels inclusive, and 35c. for the 56 per cent material, barrels extra. Not in a long time has there been such a tight condition as is now noted on acetic acid.

Sulphuric Acid: All sulphuric acid reported as unchanged from the condition that prevailed in this market a week ago. Very few offers of the 60-degree material are noted, and as a rule the buyer continues to prefer 66-degree material when same is available at a favorable figure. In some quarters it is stated that prices for stocks on spot of the 66-degree brimstone acid have advanced, but in second hands sales have been noted as low as \$32.50 per ton in sellers' tanks works. Some of the large producers, however, continue to ask as high as \$34.00 a ton sellers' tanks works for the ordinary run of business.

Oleum: For tank cars possibly \$55.00 is workable. Some business in 60 per cent oleum at \$225.00 per ton, and up, but it appears that the production has now been disposed of, and few new orders have been heard at this figure. The situation apparently continues to improve and large offerings are less frequently heard, but in view of a decidedly unsettled condition comparatively wide price ranges continue to be heard.

Yellow Prussiate of Soda: The production of this material continues to be confined to a few firms and is seemingly not sufficiently large to take care of all the business that is now being placed. Prices for spot and nearby stocks are decidedly higher at the close and in a number of important quarters as high as 75c. a pound. The inside quotation heard for this material has been at 70c. With additional inquiries there is more underlying strength than has been noted in this market for some time.

Yellow Prussiate of Potash: Domestic stocks are available at \$1.20, and up to \$1.25, according to quantity. Offerings are not large and supplies, it is reported, are barely sufficient to take care of all the business that is now being placed. The Japanese materials are nominal, since importers are unable to get ample stocks from the Orient to take care of the volume of business noted.

Cyanide of Soda: Business has been confined chiefly to second hands during the interval, and 38c. has been the figure most generally heard from this quarter. The ordinary seller, however, continues to quote firmly at 40c. and up.

Copper Sulphate: The market has been barely steady on this product, and apparently at the close 9¼c. a pound could have been shaded on a firm bid. The inquiry is active, but no large orders have been recorded and the undertone of the market is not particularly strong.

Bichromate of Soda: It is difficult to get a correct line on the prevailing conditions in the New York market on bichromate of soda. Wide price ranges are heard because of an unsettled condition and closing figures were 24¼c. as the inside, and up to 25c. a pound as the maximum. Additional inquiry interest is being manifested daily on this material.

General Chemicals

WHOLESALE PRICES IN NEW YORK MARKET, MAY 24, 1918

Acetic anhydride	lb.	1.50 —	1.60
Acetone, drums	lb.	Nominal	
Acid, acetic, 28 per cent	lb.	Nominal	
Acetic, 56 per cent	lb.	Nominal	
Acetic, glacial, 99½ per cent., carboys	lb.	Nominal	
Boric, crystals	lb.	.13¾ —	.14¼
Citric, crystals	lb.	.87 —	.88
Hydrochloric, C. P	lb.	Nominal	
Hydrochloric, 20 deg	lb.	.02½ —	.02¾
Hydrochloric, conc., 22 deg	lb.	.02½ —	.03
Hydrofluoric, 30 per cent., in barrels	lb.	.06 —	.06½
Lactic, 44 per cent	lb.	.11 —	.12
Lactic, 22 per cent	lb.	.06 —	.06½
Molybdic, 85 per cent	lb.	3.85 —	.....
Nitric, 36 deg	lb.	.08½ —	.08¾
Nitric, 42 deg	lb.	.09 —	.10
Oxalic, crystals	lb.	.42 —	.43
Phosphoric, 47–50 per cent. paste	lb.	.08 —	.10
Phosphoric, ref. 50 per cent	lb.	.26 —	.....
Picric	lb.	Nominal	
Pyrogallic, resublimed	lb.	3.10 —	3.15
Sulphuric, 60 deg	ton	25.00 —	27.50
Sulphuric, 66 deg	ton	32.50 —	35.00
Sulphuric, oleum (Fuming), tank cars	ton	55.00 —	60.00
Tannic, U. S. P., bulk	lb.	1.30 —	1.35
Tartaric, crystals	lb.	.86 —	.87
Tungstic, per lb. of W	lb.	1.70 —	1.75
Alcohol, sugar cane, 188 proof	gal.	4.93 —	4.95
Alcohol, wood, 95 per cent	gal.	.90½ —	.91
Alcohol, denatured, 180 proof	gal.	.68 —	.69
Alum, ammonia lump	lb.	.04 —	.04½
Alum, chrome ammonium	lb.	.18 —	.19
Alum, chrome potassium	lb.	.20 —	.21
Alum, chrome sodium	lb.	.12½ —	.13
Alum, potash lump	lb.	.08½ —	.09
Aluminium sulphate, technical	lb.	.02½ —	.03
Aluminium sulphate, iron free	lb.	.03¼ —	.03½
Ammonia aqua, 26 deg. carboys	lb.	.26 —	.27
Ammonia, anhydrous	lb.	Nominal	
Ammonium carbonate	lb.	Nominal	
Ammonium nitrate	lb.	(Fixed price)	.15
Ammonium, sulphate domestic	lb.	.07¾ —	.08
Amyl acetate	gal.	5.00 —	5.25
Arsenic, white	lb.	.09 —	.12
Arsenic, red	lb.	.35 —	.40
Barium carbonate, 99 per cent	ton	80.00 —	90.00
Barium carbonate, 97-98 per cent	ton	65.00 —	67.00
Barium chloride	ton	65.00 —	85.00
Barium sulphate (Blanc Fixe, Dry)	lb.	.02¼ —	.02½
Barium nitrate	lb.	.09½ —	.10
Barium peroxide, basis 70 per cent	lb.	.30 —	.32
Bleaching powder, 35 per cent. chlorine	lb.	.01 —	.02
Borax, crystals, sacks	lb.	.07¾ —	.08¼
Brimstone, crude	ton	Nominal	
Bromine, technical	lb.	.75 —	.....
Calcium, acetate, crude	lb.	Nominal	
Calcium, carbide	lb.	.12½ —	.14½
Calcium chloride, 70-75 per cent., fused, lump	ton	27.50 —	30.00
Calcium peroxide	lb.	1.60 —	1.70
Calcium phosphate	lb.	.34 —	.35
Calcium sulphate 98-99 per cent	lb.	.09 —	.09½
Carbon bisulphide	lb.	.08½ —	.10
Carbon tetrachloride, drums	lb.	.15½ —	.16
Carbonyl chloride (phosgene)	lb.	1.10 —	1.50
Caustic potash, 88-92 per cent	lb.	.83½ —	.84
Caustic soda, 76 per cent	lb.	.04¼ —	.04½
Chlorine, liquid	lb.	.15 —	.18
Cobalt oxide	lb.	1.60 —	1.65
Copperas	lb.	.01¼ —	.01½
Copper carbonate	lb.	.30 —	.40
Copper cyanide	lb.	.75 —	.78
Copper sulphate, 99 per cent., large crystals	lb.	.08¾ —	.09
Cream of tartar, crystals	lb.	.80 —	.82
Epsom salt, bags, U.S.P	lb.	.03¼ —	.03½
Formaldehyde, 40 per cent	lb.	.18½ —	.19
Glauber's salt 100	lb.	1.50 —	1.75
Glycerine, bulk, C. P	lb.	.63½ —	.64
Iodine, resublimed	lb.	4.25 —	4.30
Iron oxide	lb.	.13 —	.15
Lead, acetate, white crystals	lb.	.17 —	.18
Lead, arsenate (Paste)	lb.	.15 —	.18
Lead nitrate	lb.	.15 —	.16
Litharge, American	lb.	.09½ —	.11½
Lithium carbonate	lb.	1.50 —	2.00
Manganese dioxide, U. S. P	lb.	.70 —	.75
Magnesium carbonate, technical	lb.	.10½ —	.11
Nickel salt, single	lb.	.14 —	.15
Nickel salt, double	lb.	.12 —	.14
Phosgene, see Carbonyl chloride			
Phosphorus, red	lb.	1.30 —	1.50
Phosphorus, yellow	lb.	1.50 —	1.60
Potassium bichromate	lb.	.44 —	.46
Potassium bromide granular	lb.	1.35 —	1.50
Potassium carbonate calcined, 85-90 per cent	lb.	.40 —	.50
Potassium chlorate, crystals	lb.	.38 —	.40
Potassium cyanide, 98-99 per cent	lb.	Nominal	
Potassium iodide	lb.	3.75 —	3.80
Potassium muriate 80-85 p. c. basis of 80 p. c.	ton	325.00 —	350.00
Potassium nitrate	lb.	.27 —	.31
Potassium permanganate (U. S. P.)	lb.	3.65 —	3.75
Potassium prussiate, red	lb.	2.80 —	2.90
Potassium prussiate, yellow	lb.	1.15 —	1.20
Potassium sulphate, 90-95 p. c. basis 90 p. c.	ton	Nominal	
Rochelle salts	lb.	.43 —	.44
Salammoniac, gray gran	lb.	.18 —	.19
Salammoniac, white gran	lb.	.17½ —	.18
Sal soda 100	lb.	1.35 —	1.40
Salt cake	ton	22.50 —	25.00
Silver cyanide, based on market price of silver	oz.	.... —	....
Silver nitrate	oz.	.61½ —	.62
Soda ash, 58 per cent., light, flat (bags) 100	lb.	2.10 —	2.20

Soda ash, 58 per cent., dense, flat . . . 100	lb.	3.75	—	3.85
Sodium acetate	lb.	.23	—	.24
Sodium bicarbonate, domestic	lb.	.02½	—	.03
Sodium bicarbonate, English	lb.	....	—	....
Sodium bichromate	lb.	.23½	—	.24½
Sodium bisulphite, powd	lb.	.05½	—	.06
Sodium chlorate	lb.	.24	—	.25
Sodium cyanide	lb.	.38	—	.40
Sodium fluoride, commercial	lb.	.18	—	.19
Sodium hyposulphite	lb.	.02¼	—	.02½
Sodium molybdate, per lb. of Mo	lb.	2.50	—	.....
Sodium nitrate, 95 per cent . . . 100	lb.	Nominal		
Sodium nitrite	lb.	.29	—	.32
Sodium peroxide	lb.	.48	—	.50
Sodium phosphate	lb.	.04	—	.05
Sodium prussiate, yellow	lb.	.68	—	.69
Sodium silicate, liquid (60 deg.)	lb.	Nominal		
Sodium sulphide, 30 per cent., crystals	lb.	.02½	—	.03
Sodium sulphide, 60 per cent., fused	lb.	.05½	—	.06
Sodium sulphite	lb.	Nominal		
Strontium nitrate	lb.	.25	—	.35
Sulphur chloride, drums	lb.	.06	—	.06½
Sulphur dioxide, liquid, in cylinders	lb.	.15	—	.40
Sulphur, flowers, sublimed . . . 100	lb.	4.05	—	4.60
Sulphur, roll . . . 100	lb.	3.70	—	3.85
Sulphur, crude	ton	Nominal		
Tin bichloride, 50 deg	lb.	.23½	—	.24½
Tin oxide	lb.	.78	—	.80
Zinc carbonate	lb.	.25	—	.30
Zinc chloride	lb.	.12½	—	.13
Zinc cyanide	lb.	Nominal		
Zinc dust, 350 mesh	lb.	.14	—	.16
Zinc oxide, American process XX	lb.	.12½	—	.14
Zinc sulphate	lb.	.05	—	.06

Coal Tar Products (Crude)

Benzol, pure, water white	gal.	.27	—	.30
Benzol, 90 per cent	gal.	....	—	....
Toluol, in tank cars	gal.	(Fixed Price)		1.50
Toluol, for non-military use, in drums	gal.	(Fixed Price)		1.55
Xylol, pure, water white	gal.	.35	—	.50
Solvent naphtha, water white	gal.	.17	—	.22
Solvent naphtha, crude, heavy	gal.	.13	—	.16
Creosote oil, 25 per cent	gal.	.33	—	.35
Dip oil, 20 per cent	gal.	.29	—	.30
Pitch, various grades	ton	8.00	—	20.00
Carbolic acid, crude, 95-97 per cent	lb.	1.05	—	1.10
Carbolic acid, crude, 50 per cent	lb.	.60	—	.65
Carbolic acid, crude, 25 per cent	lb.	.35	—	.38
Cresol, U. S. P	lb.	.18	—	.20

Intermediates, Etc.

Alpha naphthol, crude	lb.	1.00	—	1.25
Alpha naphthol, distilled	lb.	1.60	—	2.00
Alpha naphthylamine	lb.	.58	—	.60
Aniline oil, drums extra	lb.	.25½	—	.27
Aniline salts	lb.	.32	—	.34
Anthracene, 80 per cent	lb.	.50	—	.65
Benzaldehyde (f.f.c.)	lb.	5.50	—	6.00
Benzidine, base	lb.	1.75	—	1.85
Benzidine, sulphate	lb.	1.40	—	1.50
Benzoic acid U. S. P	lb.	3.75	—	3.90
Benzoate of Soda, U. S. P	lb.	3.30	—	3.40
Benzyl chloride	lb.	2.25	—	2.75
Beta naphthol benzoate	lb.	10.00	—	12.00
Beta naphthol, sublimed	lb.	.85	—	.90
Beta naphthylamine, sublimed	lb.	2.65	—	....
Dichlor benzol	lb.	.12	—	.18
Diethylaniline	lb.	4.50	—	5.00
Dinitro benzol	lb.	.35	—	.40
Dinitrochlorbenzol	lb.	.40	—	.42
Dinitronaphthaline	lb.	.55	—	.60
Dinitrotoluol	lb.	.55	—	.60
Dinitrophenol	lb.	.46	—	.50
Dimethylaniline	lb.	.70	—	.72
Diphenylamine	lb.	1.00	—	1.10
H-acid	lb.	2.25	—	2.50
Metaphenylenediamine	lb.	2.00	—	2.25
Monochlorbenzol	lb.	.17	—	.19
Naphthalene, flake	lb.	.09½	—	.09½
Naphthalene, balls	lb.	.10½	—	.10½
Naphthionic acid, crude	lb.	1.20	—	1.30
Naphthylamin-di-sulphonic acid	lb.	1.00	—	1.10
Nitro naphthaline	lb.	.45	—	.50
Nitro toluol	lb.	.50	—	.55
Ortho-amidophenol	lb.	....	—	....
Ortho-dichlor-benzol	lb.	.15	—	.18
Ortho-toluidine	lb.	1.00	—	1.25
Ortho-nitro-toluol	lb.	.75	—	1.00
Para-amidophenol, base	lb.	3.50	—	3.75
Para-amido-phenol, H. Ch	lb.	4.00	—	5.00
Para-dichlor-benzol	lb.	.12	—	.15
Paranitraniline	lb.	1.50	—	1.55
Para-nitro-toluol	lb.	1.50	—	1.60
Paraphenylenediamine (base)	lb.	3.00	—	3.25
Para toluidine	lb.	2.25	—	2.50
Phthalic acid anhydride	lb.	3.50	—	4.00
Phenol, U. S. P	lb.	.48	—	.49
Resorcin, technical	lb.	5.75	—	6.00
Resorcin, pure	lb.	8.50	—	9.00
Salicylic acid	lb.	.88	—	.90
Salol	lb.	1.90	—	2.00
Sulphanilic acid, crude	lb.	.30	—	.32
Tolidin	lb.	2.50	—	....
Toluidine-mixture	lb.	.75	—	.85

Petroleum Oils

Crude (at the Wells)

Pennsylvania	bbl.	4.00	—	....
Corning, Ohio	bbl.	2.85	—	....
Somerset, Ky	bbl.	2.60	—	....
Wooster, Ohio	bbl.	2.58	—	....
Indiana	bbl.	2.18	—	....
Illinois	bbl.	2.32	—	....
Oklahoma and Kansas	bbl.	2.25	—	....
Caddo, La., light	bbl.	2.25	—	....
Corsicana, Tex., light	bbl.	2.35	—	....
California	bbl.	1.23	—	....
Gulf Coast	bbl.	1.35	—	....

Fuel Oil

New York	gal.	.11	—	....
Pittsburgh	gal.	.07½	—	.10
Oklahoma-Kans	bbl.	1.05	—	2.75
Texas	bbl.	1.50	—	1.90
Los Angeles	bbl.	1.60	—	....
San Francisco	bbl.	1.60	—	....

Gasoline (Wholesale)

New York	gal.	.24	—	....
Boston	gal.	.25	—	....
Pittsburgh	gal.	.28	—	....
Chicago	gal.	.22½	—	....
Oklahoma	gal.	.25	—	....
San Francisco	gal.	.20	—	....

Lubricants

Black, reduced, 29 gravity, 25-30 cold test	gal.	.21	—	.22
Cylinder, light	gal.	.36	—	.38
Cylinder, dark	gal.	.35	—	.36
Paraffine, high viscosity	gal.	.40	—	.41
Paraffine, .903 sp. gr	gal.	.36	—	.38
Paraffine, .885 sp. gr	gal.	.26	—	.28

Flotation Oils

(Prices at New York unless otherwise stated)

Pine oil, crude, f. o. b. Florida	gal.	.44	—	....
Pine oil, steam-distilled, sp. gr. 0.925-0.940	gal.	.53	—	....
Pine oil, destructively distilled	gal.	.49	—	....
Pine-tar oil, sp. gr., 1.025-1.035	gal.	.35	—	....
Pine-tar oil, double refined, sp. gr. 0.965-0.990	gal.	.40	—	....
Pine-tar oil, ref., light, sp. gr. 0.950, tank cars, f. o. b. works	gal.	.34	—	....
Pine-tar oil, ref., heavy, sp. gr. 1.025, tank cars, f. o. b. works	gal.	.25	—	....
Pine-tar oil, ref., thin, sp. gr. 1.060-1.080	gal.	.32	—	....
Turpentine, crude, sp. gr. 0.870-0.900	gal.	.40	—	....
Hardwood oil, f. o. b. Michigan, sp. gr. 0.960-0.990	gal.	.19	—	....
Hardwood oil, f. o. b. Michigan, sp. gr. 1.06-1.08	gal.	.19	—	....
Wood creosote, ref. f. o. b. Florida	gal.	.31	—	....

Vegetable and Other Oils

China wood oil	lb.	.26	—	.27
Cottonseed oil, crude	lb.	.21	—	.22
Linseed oil, raw, cars	gal.	1.57	—	1.59
Peanut oil, crude	gal.	1.35	—	1.36
Rosin oil, first run	gal.	.41	—	....
Rosin oil, fourth run	gal.	.58	—	....
Soya bean oil, Manchuria	lb.	.16½	—	.16½
Turpentine, spirits	gal.	.51	—	.51½

Miscellaneous Materials

Barytes, floated, white, foreign	ton	Nominal		
Barytes, floated, white, domestic	ton	32.00	—	36.00
Beeswax, white, pure	lb.	.62	—	.64
Casein	lb.	.14½	—	.18
Chalk, light, precipitated, English	lb.	Nominal		
China clay, imported, lump	ton	17.50	—	36.00
China clay, domestic, lump	ton	12.50	—	20.00
Feldspar	ton	8.00	—	12.00
Fluorspar, gravel, f. o. b. mines	ton	30.00	—	.....
Fuller's earth, powdered . . . 100	lb.	1.00	—	1.50
Graphite, flake	lb.	.15	—	.18
Ozokerite, crude, brown	lb.	Nominal		
Ozokerite, American, refined, white	lb.	Nominal		
Red lead, dry, carloads	lb.	.10	—	.11½
Rosin, 280 lb	bbl.	7.50	—	....
Soapstone	ton	10.00	—	12.50
Talc, American, white	ton	15.00	—	22.00
White lead, dry	lb.	.09	—	.10

Refractories, Etc.

(F. O. B. Works)

Chrome brick	net ton	175.00	—	.....
Chrome cement	net ton	75.00	—	.....
Clay brick, 1st quality fireclay . . . per	1000	50.00	—	55.00
Clay brick, second quality . . . per	1000	35.00	—	40.00
Magnesite, raw	ton	30.00	—	35.00
Magnesite, calcined, powdered	ton	32.00	—	35.00
Magnesite, dead burned	net ton	50.00	—	60.00
Magnesia brick, 9x4½x2½	net ton	110.00	—	125.00
Silica brick . . . per	1000	50.00	—	60.00

Ferroalloys

Ferrocarbontitanium, 15-18 per cent., carloads, f. o. b. Niagara Falls, N. Y	ton	......	—	....
Ferrocerium	lb.	3.00	—	....
Ferrochromium, per lb. of Cr	lb.	......	—	....
Ferromanganese, domestic, 70 per cent. basis	ton	250.00	—	....
Ferromanganese, English	ton	325.00	—	....
Ferromolybdenum, per lb. of Mo	lb.	5.00	—	....
Ferrosilicon, 75 per cent., f. o. b., N. Y	ton	....	—	....
Ferrosilicon, 50 per cent., carloads, del., Pittsburgh	ton	180.00	—	190.00
Ferrosilicon, 50 per cent., contract	ton	160.00	—	170.00
Ferrotungsten, 75-85 per cent., f. o. b., Pittsburgh	lb.	2.35	—	2.40
Ferrouranium, f. o. b. works, per lb. of U	lb.	7.50	—	....
Ferrovanadium, f. o. b. works	lb.	....	—	....

Ores and Semi-finished Products

Antimony ore, per unit		....	—	....
Chrome ore, 45 per cent. minimum, f.o.b. Cal., per unit	ton	1.50	—	1.55
Chrome ore, 43 per cent. and over, New York, per unit	ton	....	—	....
Manganese ore, 48 per cent. and over, per unit	ton	1.20	—	....
Manganese ore, chemical	ton	80.00	—	100.00
Molybdenite, per lb. of MoS_2	lb.	1.25	—	....
Tungsten, Scheelite, per unit of WO_3	ton	24.00	—	....
Tungsten, Wolframite, per unit of WO_3	ton	24.00	—	....
Uranium oxide, 96%	lb.	3.25	—	3.60
Vanadium pentoxide, 99%	lb.	10.50	—	....
Pyrites, foreign	unit	.17	—	.17½
Pyrites, domestic	unit	.28	—	.30

INDUSTRIAL NEWS

Plant Construction—Catalogs—New Publications

Construction and Operation

Arizona

TUCSON.—The Pima Mining & Smelting Co. plans to enlarge the capacity of its smelter plant from 250 tons to 500 tons daily. William Kemp is manager.

California

GRASS VALLEY.—The Grass Valley Consolidated Gold Mines Co. is building a shaft, mill and cyanide plant. Estimated cost, $225,000.

OATMAN.—The Mossback Mines, at Line Road section of Gold Road property, plans to install a new crushing plant. About half a dozen buildings will be put up, powerful plant installed and main shaft sunk from present depth of 300 ft. to 500 or 600 ft.

Connecticut

BRIDGEPORT.—Whipple & Choate Co., Iranistan Ave., has awarded the contract for the construction of a 1-story, 27 x 27 ft., mill construction addition to its foundry, to H. D. Moon, 208 Stratford Rd. and T. O'Brien, 137 Black Road Ave.

HARTFORD.—The Hartford Rubber Co., Park St., has awarded the contract for the construction of a 1½-story, 50 x 150 ft., concrete, brick and steel factory on Bartholomew Ave., to S. H. Grozier Co., 721 Main St. Estimated cost, $14,000.

HARTFORD.—The Maxim Silencer Co., 81 Homestead Ave., has awarded the contract for the construction of a 1½-story, 30 x 300 ft. factory to be used for the manufacture of attachments for guns, to the Ellison Construction Co., 60 Prospect St. Estimated cost, $20,000.

WATERBURY.—The Waterbury Clock Co., 31 Cherry Ave., plans to build a large manufacturing building.

Idaho

WALLACE.—The Friend Mining Co., will install a mill consisting of crusher, ball mill, flotation machine and concentrating table.

Illinois

CHICAGO.—The Cross Press & Sign Co., c/o C. E. Frazier, 30 North Dearborn St., plans to build a 1- and 2-story, 75 x 75 ft., reinforced concrete tannery at Dayton and Black Hawk Sts. Estimated cost, $15,000.

CHICAGO.—B. Heller & Co., 3925 Calumet Ave., manufacturer of edible chemicals, plans to build a 3-story, 125 x 250 ft. brick addition to factory. J. C. Llewellyn, 38 South Dearborn St., is engineer.

CHICAGO.—The International Harvester Corporation, Chicago, has awarded the contract for the construction of a grey iron foundry, to McClintic Marshall Co., 38 South Dearborn St.

CHICAGO.—The Western Dry Color Co., 608 West 52nd St., will build a 2-story brick factory. Estimated cost, $5000.

CICERO.—The General Malleable Co., South 55th Court and West 14th St., will build a 1-story, 132 x 222 ft., brick factory and warehouse at South 55th Court and West 13th St. Estimated cost, $18,000.

GRANITE CITY.—The Commonwealth Steel Co., Pierce Building, St. Louis, Mo., will build a 1- and 2-story addition to its plant. Estimated cost, $500,000.

KANKAKEE.—The American Truck & Aeroplane Co. has purchased the plant of the Unifile Co. at Riverview, Ill., and will equip same for the manufacture of automobile motor trucks and airplanes.

Indiana

ANDERSON.—The Hill Pump Co. has awarded the contract for the construction of a 100 x 200 ft., brick and steel foundry at the south end of its plant, to the Builders Construction Co., Indianapolis. Estimated cost, $45,000.

GARY.—The Illinois Steel Co., 208 South La Salle St., Chicago, Ill., has awarded the contract for the construction of two 141,000 gallon sulphuric acid tanks at its plant here to the American Bridge Co., 208 South La Salle St., Chicago.

GARY POST.—The Gary Motor Truck Co., 610 Broadway plans to build a large addition to its plant.

SOUTH BEND.—The Malleable Steel Range Co., Cherry St. and Jefferson Blvd., plans to build a 2-story, 34 x 88 ft., brick and steel factory building. Estimated cost, $10,000.

TERRE HAUTE.—An addition will be built to the machine shop at the Gott Glass Co. Johnson & Miller, 105 South Seventh St. is the architect.

WABASH.—The Service Motor Truck Co. will build a 1-story, 75 x 200 and 75 x 450 ft. factory. Nicol & Dietz, 212 Murdock Building, La Fayette, architects.

DES MOINES.—The Green Foundry & Furnace Works, 100-10 South West 2nd St., plans to build a 106 x 110 ft., brick and steel foundry. Frank D. Chase, Inc., 122 South Michigan Ave., Chicago, Ill., is engineer.

Iowa

FORT MADISON.—The Karamoid Manufacturing Co. will build a 2-story, 60 x 200 ft., brick, pulp container factory here by day labor. F. J. Klein, 127 South Jefferson St., architect, will supervise construction.

SIOUX CITY.—The Sioux City Tire & Manufacturing Co. plans to construct several new additions to its plant.

STORM LAKE.—The International Chemical Co. will build a factory at Lakeside Farm, a mile from the city, for the manufacture of phenol to be used by the Government in the manufacture of explosives.

Kansas

BAXTER SPRINGS.—C. M. Mitchell, E. D. Nix and L. D. Knight will build 75 ton concentrating mill at mine here to include crushers, slime tables, engines and boilers. Estimated cost, $50,000.

Massachusetts

CAMBRIDGE.—Harvard University will build a biophysical laboratory on Huntington Ave. Estimated cost, $60,000. Coolidge & Shattuck, Ames Building, Boston, architects.

NORTHAMPTON.—The Trustees of Smith College, College Hall, have awarded the contract for the construction of a brick addition to the chemistry building, to Allen Bros., 125 South Pleasant St., Amherst.

WORCESTER.—The Worcester Stamped Metal Co., 9 Hunt St., has awarded the contract for the construction of a 1-story, brick addition to its plant, to E. J. Cross Co., 82 Foster St. Estimated cost, $10,000.

Michigan

DETROIT.—The Ford Motor Co., Highland Park, will build an addition to its plant consisting of 16 shops, 18 x 360 ft. The new plant will be used for the assembly and testing of the Liberty Motor.

DETROIT.—The McCord Manufacturing Co., Grand Boulevard and Orleans St., has awarded the contract for the construction of a 1- and 3-story 161 x 372 ft. reinforced concrete munition factory, to Pleas Construction Co., 30 North La Salle St., Chicago, Ill. Estimated cost, $70,000.

Minnesota

ST. PAUL.—The American Hoist & Derrick Co., Water and Roberts Sts., has awarded the contract for the construction of a 1-story, 20 x 40 x 74 ft., brick and steel machine shop, to G. J. Grant Construction Co., Exchange Bank Building. Estimated cost, $19,250.

Missouri

PLEASANT HILL.—City let contract for sewage disposal plant to Lynch & McDonald Construction Co., Moberly.

SENECA.—The Oklamo Mining Co. plans to install slime tables, rock crushers, engines and boilers in its mine here. Estimated cost, $75,000. C. T. Jobes, is superintendent in charge.

ST. JOSEPH.—The Berry Iron and Steel Co., 5th and Oak Sts., has awarded the contract for the construction of a new plant to replace the one destroyed by fire, to the Lehr Construction Co., 1712 Fred Ave. It will consist of five buildings for work rooms and one for the office, of concrete, brick and steel construction.

WEST PLAINS.—The Missouri Iron & Steel Corporation, plans to build a smelting plant here. The operations of the company are in Howell County but will be extended to adjoining counties in North Arkansas and South Missouri. Estimated cost, $6,000,000.

Montana

POLARIS.—The Silver Fissure Mining Co. will build a salt roasting and hyposulphite plant here.

Nebraska

PLATTSMOUTH.—The Auto Power & Malleable Co. has taken over the plant and business of the Western Machine Foundry Co. and will build a new and larger plant. Estimated cost, $250,000.

New Jersey

HOBOKEN.—W. & A. Fletcher Co., 1304 Hudson St., has awarded the contract for the construction of a 3-story, 50 x 145 ft., brick factory for the manufacture of marine engines, etc., to William Crawford, 7 East 42nd St., New York City. Estimated cost, $50,000.

HOBOKEN.—The Remington Arms Co.-Union Metallic Cartridge Co., 1500 Hudson St., has awarded the contract for the construction of a 1-story, 81 x 160 ft., reinforced concrete, brick and steel factory, to Austin Co., 16112 Euclid Ave., Cleveland, O. Estimated cost, $40,000.

JERSEY CITY.—The Vulcan Iron Works, Morris St., plans to build two 1-story, 60 x 100 ft., brick and steel additions to its plant on Hudson St. Estimated cost, $50,000.

MILLVILLE.—The International Glass Co. has awarded the contract for the construction of a 1-story, 60 x 104 ft., concrete, brick and steel, glass factory here, to Austin Co., 16112 Euclid Ave., Cleveland, O. Estimated cost, $25,000.

NEWARK.—C. A. Goldsmith, Ave. D and Thomas St., will build a 1-story, 50 x 150 ft., brick brass foundry. Estimated cost, $24,000.

NEWARK.—The Holophane Glass Co., east side of Oakwood Ave., near the Pennsylvania Railroad tracks, will build a 50 x 75 ft. tank shop. Capacity, two and one half tons of molten glass.

TRENTON.—The Trenton Malleable Iron Co., New York Ave., has awarded the contract for the construction of a 1-story, 44 x 146 ft., concrete, brick and steel foundry addition, to N. A. Bugbee Co., 231 West State St. Estimated cost, $10,000.

New York

BUFFALO.—The Acme Steel & Malleable Iron Works, 120 Chandler St., has awarded the contract for the construction of a 1-story 100 x 175 ft., brick and steel iron plant, to J. W. Cowpers Co., Fidelity Building. Estimated cost, $25,000.

BUFFALO.—The Ferguson Steel & Iron Co., 1399 Bailey Ave., has warded the contract for the construction of a 1-story, 400 x 800 ft., concrete, brick and steel shipbuilding plant, to J. W. Cowpers Co., Fidelity Building. Estimated cost, $100,000.

BROOKLYN.—The Decorated Metals Co., 196 Degraw St., has awarded the contract for altering the tenement at 192 Degraw St. into a factory for its own use, also building 1-story addition, to H. D. Best Co., 52 Vanderbilt Ave., New York City. Estimated cost, $20,000.

BROOKLYN.—The Improved Appliances Co., manufacturer of gas appliances, 455 Kent Ave., plans to build a 4-story, 60 x 92 ft., reinforced concrete, brick and timber factory. Estimated cost, $15,000.

LONG ISLAND CITY.—The John Palacheck Bronze & Iron Co., 480 Hancock St., will build a 1-story, 75 x 100 ft., concrete and brick foundry. R. Holstein is architect. Estimated cost, $35,000.

LONG ISLAND CITY.—The Central Smelting & Refining Co., 220 Rider Ave., has awarded the contract for the construction of a 1½ story, 75 x 180 ft. smelting plant, to McGobar Construction Co., 1178 Broadway, New York City. Estimated cost, $51,000.

LONG ISLAND CITY—The John Palacheck Bronze & Iron Co., 480 Hancock St., will build a one story, 75 x 100 ft., brick foundry. Estimated cost, $35,000.

MASPETH.—The Dukeshire Steel & Forge Co. will build a 1-story foundry on the west side of Creek St., 75 ft. north of Grand St. Estimated cost, $15,000.

NEW YORK.—New York University, University Heights, plans to build a 1-story, 60 x 105 ft., brick and steel laboratory on the east side of Sedgwick Ave., north of 180th St., Bronx Borough. Estimated cost, $25,000. Day & Klauder, 925 Chestnut St., Philadelphia, Pa., architect.

ROCHESTER.—The High Speed Hammer Co., Norton St., will build a plant consisting of two buildings, at Clinton Ave., N., and Hellenbeck St., one to be 1-story, 53 x 101 ft. and another 2-story, 18 x 53 ft. Estimated cost, $40,000.

Ohio

CANTON.—The Timken Roller Bearing Co., Dueber Ave., will build a steel manufacturing building. Estimated cost, $180,000. The company recently obtained a large order from the Government for automobile machinery.

CINCINNATI.—The Cincinnati Gear Co., 1825 Reading Road, will build a 1-story, concrete and brick addition to its factory. Estimated cost, $24,000.

CINCINNATI.—The City will build a new asphalt plant on Florence Ave., to replace the one destroyed by fire, entailing a loss of $20,000.

CINCINNATI.—(Norwood) The George B. Curd Co. has purchased the factory on Highland Ave. formerly occupied by the Niebling Ice Machine Co. and will remodel same for its own use as a locomotive repair shop.

CINCINNATI.—The John H. McGowan Co., 52 Central Ave., will remodel, also build an addition, to its machine plant. Estimated cost, $10,000.

CINCINNATI.—The John B. Morris Foundry Co., Court and Harriet Sts., will improve its plant. Estimated cost, $10,000.

CINCINNATI.—(Oakley) The Trailmobile Co. manufacturer of automobile trailers, will build a manufacturing building to contain 80,000 sq.ft. floor space. Estimated cost, $300,000. E. M. Chase, Union Centre Building, is engineer.

CLEVELAND.—The Crucible Steel Forge Co., Grant Ave., plans to build a 1-story shop addition. Estimated cost, $30,000.

CLEVELAND.—The Damascus Manufacturing Co., manufacturer of oil specialties, East 93rd and Cassius Sts., has awarded the contract for the construction of a 2-story, 30 x 50 and 80 x 105 ft., concrete, brick and steel factory addition, to J. H. Chaney & Son Co., 563 Hippodrome Annex. Estimated cost, $30,000.

CLEVELAND.—The Templin-Crockett-Bradley Co., 5700 Detroit Ave., has awarded the contract for the construction of an addition to its plant, to F. A. Skeel, 3719 Cypress Ave. Estimated cost, $30,000.

CLEVELAND.—The Wilberite Roofing Co., Brook Park and State Roads, is building a new factory here. Estimated cost, $22,000.

CLEVELAND.—The Willard Storage Battery Co., 274 East 131st St., plans to build a concrete, brick and steel factory and office building. Estimated cost, $150,000.

COLUMBUS.—The Atlas Brass Foundry Co., Stewart Ave. and Park St., S., has awarded the contract for the construction of a new factory addition, to Nonnemacher & Frank, East Gates St. Estimated cost, $8000.

COLUMBUS.—The Columbus Rendering Co., Frank Road and Jackson Pike, has awarded the contract for the construction of a 2-story, 32 x 72 ft. brick rendering plant, to E. Elford, Commercial Building. Estimated cost, $15,000.

DAYTON.—The Advance Foundry Co., Harshman and Crane Sts., plans to build a new grey iron foundry on Parnell Ave., near the Pennsylvania R.R. Estimated cost, $200,000.

EUCLID.—The Euclid Chemical Co., c/o R. L. Beck, 311 The Arcade, Cleveland, will build a 3-story, reinforced concrete, brick and steel factory. Estimated cost, $50,000.

HAMILTON.—The Black & Clawson Co., 2nd and Vine Sts., builder of paper-making machinery, has awarded the contract for the construction of a 1-story, 60 x 80 ft., brick and steel addition to its foundry, to Bert L. Baldwin Co., 502 Second National Bank Building, Cincinnati.

LONDON.—The London Fabrics Mill Co., recently incorporated, will build a 60 x 70 ft. brick and steel factory for the manufacture of fabrics to go into rubber tires.

NORWOOD.—The A. V. Carroll Machine Tool Co., Highland Ave., has awarded the contract for the construction of a new plant, to F. E. Ratcliff, Batavia. Estimated cost, $10,000.

NORWOOD.—The Warman Aluminum Castings Co., 1741 Central St., Cincinnati, has leased a building at Main and Lexington Aves. and will equip same for the manufacture of aluminium castings.

SANDUSKY.—The Farrell Cheekseel Foundry, foot of 1st St., will build an addition to its plant.

SANDUSKY.—The Vim Motor Co., Water and Meigs Sts., has awarded the contract for the construction of a 100 x 180 ft. addition to its plant, to A. S. Schnurr, 1003 West Jefferson St.

TOLEDO.—The Bunting Brass & Bronze Co., Spencer and Carlton Sts., will build a 2-story, 120 x 175 ft., brick, cement and steel brass foundry. Estimated cost, $150,000. Mills, Rhines, Bellman & Nordhoff, 1234 Ohio Building, architects.

TOLEDO.—The Royster Guano Co., 813 Second National Bank Building, will build a fertilizer plant on Stickney Ave. Estimated cost, $35,000.

TOLEDO.—The Toledo Tap & Die Co., Clinton St., plans to build a 1-story, 50 x 200 ft., concrete, brick and steel factory, for the manufacture of machine tools, taps and dies. Estimated cost, $20,000.

WARREN.—The A. B. Smith Chemical Co., Red House, will build a new plant to replace the one destroyed by fire with a loss of $150,000.

Oklahoma

BARTLESVILLE.—The Bureau of Mines plans to build a 2-story, 42 x 102 ft. laboratory of brick construction. Keene & Simpson, 400 Reliance Building, architects. Estimated cost, $30,000.

GUTHRIE.—The Empire Oil & Gas Co. plans to build a second oil refinery here.

MIAMI.—The Lightfoot Oil & Mining Co. will build a 100 ton concentrating mill to include slime tables, crushers, engines, boilers and air machines. Estimated cost, $100,000. H. Holman, is vice president.

MIAMI.—The Mint Mining Co. will build two 75 ton concentrating mills to include slime tables, crushers, boilers and engines. Estimated cost, $100,000. Julius Labsap is superintendent.

Pennsylvania

FORD CITY.—The Fawcus Machine Co. plans to build a 50 x 100 ft. addition to its plant here. The Company recently obtained several large Government orders which make this addition necessary.

MORRISTOWN.—The Conshohocken Iron & Steel Co. plans to build a modern ore crushing mill, for crushing chrome ore, which is used in steel making, furnace lining and other work.

PHILADELPHIA.—The Aetna Foundry Co., 22nd St. and Allegheny Ave., has awarded the contract for the construction of a 1-story, 50 x 70 and 20 x 50 ft., brick foundry, to A. Raymond Raff, 17th and Thompson Sts. Estimated cost, $10,000.

PHILADELPHIA.—The Cresson & Morris Co. has awarded the contract for the construction of a 50 x 100 ft. foundry at 18th St. and Allegheny Ave., to the Raith Construction Co., 302 West Master St.

PHILADELPHIA.—Morris Wheeler & Co. has awarded the contract for the construction of a 467 x 616 x 325 ft. fabricating steel shop, fireproof, to William Steele & Sons, 308 South 15th St. Estimated cost $500,000.

PHILADELPHIA.—The United States Government will build a 1-story, 57 x 154 ft., brick and reinforced concrete, aircraft factory at League Island. Estimated cost, $20,000. W. Delley, 1616 Thompson St., is architect.

PITTSBURGH.—The C. R. Moore Co., Arrott Tower Building, plans to build a 1-story, concrete, brick and steel printing house on West Liberty Ave., Nineteenth Ward. Estimated cost, $45,000.

Rhode Island

PAWTUCKET.—The Collyer Insulated Wire Co., 249 North Main St., will build a 3 story, 83 x 170 ft. brick manufacturing plant. Estimated cost, $80,000.

Tennessee

LYLES.—The United States Government has awarded the contract for the construction of a wood chemical plant, to George A. Fuller Construction Co., 175 5th Ave., New York City. Estimated cost, $1,300,000. The Bon Air Coal & Iron Corporation, Stahlman Building, Nashville, will operate the plant for the Government.

Texas

WACO.—W. McMahon, 802 Kipling St., plans to build a refinery at the South Bosque oil fields.

Utah

SALT LAKE.—The Lucky Star Copper Co. plans to build a small concentration plant at its mine in the Dugway District.

Virginia

SEVEN PINES.—The War Department, Washington, D. C., has awarded the contract for the construction of a powder packing plant here, to the Foundation Co., Woolworth Building, 233 Broadway, New York City. Estimated cost, $3,000,000. E. I. DuPont de Nemours & Co., Henry Clay St., Wilmington, Del., will operate the plant for the Government.

Washington

EVERETT.—Everett Lister plans to build a plant here for the manufacture of potash from wood ashes and later from kelp.

EVERETT.—The Everett Steel Co. will build a 75 x 100 ft., brick building on McDougall St. between Wall St. and Smith Ave. T. B. Sumner of Sumner Iron Works is president of new company.

SPOKANE.—The Armstead Mines will build a concentrating mill and purchase additional equipment. Estimated cost, $100,000. The first unit of the plant will have about 100 tons capacity.

West Virginia

FAIRMONT.—The Fairmont By-Products Co. will build a by-product coke oven plant. Initial capacity 110 tons ovens and ultimate 330. Estimated cost, $5,000,000.

SUTTON.—The Sutton Chemical Co. will build an addition to its plant here. Estimated cost, $200,000. The company recently obtained large contracts from the Government which makes this addition necessary.

Wisconsin

CARROLLVILLE.—The Newport Chemical Works, manufacturer of phenol products 1112 First National Bank Building, Milwaukee, will build an addition to its plant here.

EAU CLAIRE.—The United States Switch Co. plans to build additions to double the capacity of its foundry and install milling machines, turret lathes and a one-ton electric steel furnace. A complete drop forge unit also will be added.

MILWAUKEE.—The Universal Machinery Co., 784 30th St., manufacturer of lathes and other machine tools, plans to build a new foundry and machine shop at the foot of 64th Ave. Estimated cost, $250,000. Frank E. Gray, 86 Michigan St., is architect.

PLYMOUTH.—The National Milk Sugar Co., 16 Park Row, New York City, will build a 1-story and 2-story, 40 x 120 ft., brick and mill construction sugar refinery here. Estimated cost, $20,000.

WEST ALLIS.—The Universal Machinery Co., 784 30th St., will build a 150 x 250 ft. factory, 100 x 150 ft. foundry, and a 50 x 50 ft. power house. Estimated cost, $250,000. E. C. Devine is president.

Canada

ILLICILLEWAET, B. C.—The Lanark Mines Co. is installing hydro electric plant at its mine here. Estimated cost, $300,000.

Industrial News

The CLARAGE FAN COMPANY, Kalamazoo, Mich., announces the removal of their Chicago branch to Room 1666, Conway Building, 111 W. Washington Street, under the management of Gardner J. Thomas.

The INDUSTRIAL ELECTRIC FURNACE Co., of Chicago, makers of the Snyder furnace, have shipped a 1250-lb. capacity electric steel furnace, together with the auxiliary electrical equipment, to Burn & Co., Calcutta, India, the largest iron, steel and foundry company in India. The purchase of this Snyder furnace shows the progressive tendency toward modern equipment and modern practice in that field.

The ASBESTOS PROTECTED METAL COMPANY of Pittsburgh changed its name on May 1st to the Aspromet Company. When this company was established, in 1905, its sole product was asbestos protected metal. Their initial product meeting with favor resulted in their complementing the same by adding to their line other building materials used and bought by the same people who use and buy asbestos protected metal. Now they have a complete line of building material specialties, many of which contain neither asbestos nor metal in their make-up. Thus, the descriptive name, Asbestos Protected Metal Company, which originally served them so well, became restrictive to the point of being misleading; hence the change.